Printed on Thin Paper for Foreign Circulation.

DEC 6 1923

Established 1856.

The Engineer.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXXXVI.—No. 3543] LONDON: FRIDAY EVENING, NOVEMBER 23, 1923 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

CRANES.

Sealed Tenders will be received by the Director of Army Contracts until 11 a.m. on the 4th December, 1923, for the PURCHASE of :—

ONE 15-TON STEAM LOCOMOTIVE JIB CRANE, 58ft. jib; boiler by Spencer Hopwood; makers, Ransome and Rapier.

ONE 15-TON STEAM LOCOMOTIVE JIB CRANE with PILE-DRIVING ATTACHMENT, 30ft. swan-neck jib; boiler by Spencer Hopwood.

PILE DRIVER, 30 cwt. Southgate Steam Monkey, can be drawn up 14ft. 6in.; makers, Craven Bros., Ltd.

Forms of Tender, conditions of contract and any further particulars may be obtained on application to the DIRECTOR OF ARMY CONTRACTS (D.C. Sales), Imperial House, Tothill-street, Westminster, S.W. 1. 4184

The Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, REQUIRES :—

COPPER and BRASS BOLT, ROD, TUBING, PLATES and SHEETS, and BABBITT'S METAL.

Tenders due on the 11th December, 1923.
Tender forms obtainable from above. 4150

Assistant Engineers (8) REQUIRED for the PUBLIC WORKS DEPARTMENT of the FEDERATED MALAY STATES for four years' service, with prospect of permanency. Salary 400 dollars a month, rising to 800 dollars a month by annual increments of 25 dollars a month, plus a temporary non-pensionable allowance of 10 per cent. for bachelors and 20 per cent. for married men. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is at present considerably less than that of 2s. 4d. in the United Kingdom. Free passage provided. Candidates, age 25 to 35, preferably unmarried, must have received a good theoretical training, preferably at a University or Engineering College recognised by the Institution of Civil Engineers, or have completed articles with civil engineer of good standing and have passed the examination for Associate Membership of the Institution of Civil Engineers. Possession of an engineering or science degree preferred. Must have had at least two years' practical experience in the design and execution of works of some considerable magnitude. A knowledge of modern roadmaking and maintenance is desirable.—Apply at once by letter, giving brief details of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting at top of application M/16,409. 4148

Cape Technical College, Cape TOWN.

APPLICATIONS are INVITED for SENIOR LECTURER in ELECTRICAL ENGINEERING. Salary £450-25-650.

Applications, which will be received up to the 10th December, 1923, must be accompanied by certified copies of testimonials of works and teaching experience and should state age of applicant.

The holder of this post will be required to join the Government Provident Fund and must contribute 6 per cent. of his salary.

Two years' probation, subject to six months' notice either side; afterwards, three months' notice.

£50 allowed for travelling expenses, but a proportionate amount of this to be repaid if the contract is terminated in less than two years.

Teaching experience may be taken into consideration when deciding the initial salary.

Apply in first case to Messrs. CHALMERS GUTHRIE and CO., Ltd., 9, Idol-lane, London, E.C. 4185

Administrative County of LONDON.

The London County Council invites TENDERS for PIPING, VALVES, PUMPS, &c., required in connection with Abbey Mills Pumping Station, Abbey-lane, Stratford, London, E. 15.

Persons desiring to submit Tenders may obtain the drawings, specification, form of Tender, &c., on application to the Chief Engineer at the Old County Hall, Spring-gardens, Charing Cross, S.W. 1, upon payment of the sum of £5. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained upon personal application, and the drawings, specification, and other contract documents may be inspected at the Old County Hall before payment of the fee.

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 10th December, 1923, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
4186 Clerk of the London County Council.

Air Compressor, Motor, Pump, and BRASS or C.I. PNEUMATIC TUBES for Automatic Delivery of Telegrams. Tender forms, specifications, &c., obtainable from SUPPLY OFFICER, Australia House, London, W.C. 2. Tenders returnable in Australia on 8th January, 1924. 4171

Goole Urban District Council.
WATER DEPARTMENT.

The Goole Urban District Council are prepared to receive TENDERS for the PURCHASE of the whole of the MACHINERY and the BOILER at the Rawcliffe Bridge Waterworks.

Tenders, endorsed "Machinery and Boiler," should reach me not later than Twelve o'clock Noon on 7th December next.

Further particulars may be obtained on application to Mr. A. F. Yates, Engineer and Manager, Gasworks, Doyle-street, Goole.

The Council do not bind themselves to accept the highest or any Tender.

J. W. PULLON,
Clerk to the Council.
Council Offices, Goole.
15th November, 1923. 4170

The Brighton Marine Palace and PIER COMPANY invite TENDERS for the EXTENSION of their LANDING STAGE.

Specifications may be obtained and drawings seen at the Palace Pier, Brighton, or at the office of the Engineer, M. Noel Ridley, Standard House, 135, Cardigan-road, Leeds.

Tenders to be sent to the COMPANY, Palace Pier, Brighton, on or before Friday, the 7th December, 1923, Twelve o'clock Noon. The Company do not bind themselves to accept the lowest or any Tender. P8835

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

A Scott-Still Marine Oil Engine.

Ship Form and Steering—No. I.

Mercury Vapour Turbine.

Short Histories of Famous Firms:—No. XVII.
(KITSON & CO., LTD.).

The Wireless Exhibition—No. III.

The History of Metallurgical Science.

Public Works Congress.

Large Bridge Erecting Crane.

PUBLIC NOTICES

Port of Bristol.
CONSTRUCTION OF EASTERN ARM, ROYAL EDWARD DOCK, AVONMOUTH.

The Docks Committee are prepared to receive TENDERS for the CONSTRUCTION of the EASTERN ARM of the ROYAL EDWARD DOCK, AVONMOUTH.

The work will consist principally of the removal and carrying to spoil of the main excavation for the arm of the dock, together with the construction of a ferro-concrete built wharf about 1700ft. long on each side. Also the construction of two three-floor ferro-concrete built transit sheds, each 500ft. long; and a ferro-concrete built silo granery of about 6000 tons capacity.

On and after Monday, the 26th inst., copies of the specification and contract drawings can be obtained from the undersigned on the production of a receipt showing that a deposit of £15 has been paid to the Docks Committee at 19, Queen-square, Bristol, to whom all cheques must be made payable. The deposit of £15 will be returned to all bona fide tenderers after the receipt of a Tender accompanied by all the prescribed documents and drawings.

Tenders must be enclosed in a sealed envelope, endorsed "Tender for Construction of Eastern Arm, Royal Edward Dock, Avonmouth," and addressed to the General Manager and Secretary of the Docks Committee, 19, Queen-square, Bristol, and must be delivered to him, accompanied by all the prescribed documents and drawings, before 10 a.m. on Monday, the 7th day of January, 1924.

The Docks Committee do not bind themselves to accept the lowest or any Tender.

THOMAS A. PEACE,
Chief Engineer,
Port of Bristol.
Chief Engineer's Office,
Avonmouth Docks.
20th November, 1923. 4187

The Great Indian Peninsula RAILWAY COMPANY, 48, Custhall-avenue, London, E.C. 2, invite TENDERS for :—

	For.
1. LEAD SHEETS	5s.
2. INDIA-RUBBER HOSE PIPES, SHEETS, &c.	5s.
3. CANVASES, &c.	5s.
4. GALVANISED SHEETS	2s. 6d.
5. BRASS SHEETS, COPPER TUBES, &c.	10s.
6. DRYSALTERIES	2s. 6d.
7. RAMPS	2s. 6d.
8. MILD STEEL BARS	£1
9. VERTICAL BOILERS	10s.

Tenders are due by 11 a.m. on 4th December, 1923. Tender forms obtainable at above address. Fees not returnable. 4188

London and North-Eastern RAILWAY.

The Directors are prepared to receive TENDERS for the CONSTRUCTION of the STEEL SUPERSTRUCTURE of a BRIDGE to carry the Pontop and South Shields Branch over a new road through the Deans, in course of construction by the Borough of Shields.

The contract comprises the supply and erection of the whole of the steel work (about 40 tons), &c.

Drawings and specification may be seen and detailed quantities and form of Tender obtained on personal application at the office of the Chief Engineer, North-Eastern Area, York. Sealed Tenders, marked "Tender for Deans-road Bridge, Pontop and South Shields Branch," must be received by the Joint Secretaries, London and North-Eastern Railway, Marylebone Station, London, N.W. 1, by 9 a.m., November 29th, 1923.

The Directors do not bind themselves to accept the lowest or any Tender.

JAMES McLAREN,
G. F. THURSTON,
Joint Secretaries.
Marylebone Station,
19th November, 1923. 4191

PUBLIC NOTICES

Tyne Improvement Commission.
SINGLE-SCREW STEAM STEEL MOORINGS VESSEL.

The Tyne Improvement Commissioners are prepared to receive TENDERS for the CONSTRUCTION and DELIVERY of a SINGLE-SCREW STEAM STEEL MOORINGS VESSEL, to be used for drawing and fixing mooring screws in the bed of the River Tyne and for salvage work, of the following approximate dimensions :—

Length overall	113ft. 4in.
Length between perpendiculars	105ft. 0in.
Breadth moulded	30ft. 0in.
Depth moulded	11ft. 6in.

Vessel to have a speed of seven knots.

Copies of the form of Tender, conditions of contract, general specification, and outline drawing may be obtained on application to the undersigned on payment of a deposit of £2 2s., which will be returned on receipt of a bona fide Tender.

Tenders must be sent to the undermentioned offices under cover, addressed to "The Chairman, Dredging and River Works Committee," and endorsed "Tender for Moorings Vessel," not later than Noon on Monday, the 10th day of December, 1923.

The Commissioners do not bind themselves to accept the lowest or any Tender.

By Order,
ALBERT BLACKLOCK,
Secretary.
Tyne Improvement Commission Offices,
Bewick-street, Newcastle-upon-Tyne,
20th November, 1923. 4185

Tyne Improvement Commission.
CONSTRUCTION OF TIMBER JETTY IN HOWDON YARD BAY.

The Tyne Improvement Commissioners are prepared to receive TENDERS for the CONSTRUCTION of a TIMBER JETTY at their Howdon Yard.

Copies of the form of Tender, conditions of contract, specification, and drawing may be obtained on application to the undersigned on payment of a deposit of £2 2s., which will be returned on receipt of a bona fide Tender.

Tenders, in sealed envelopes, endorsed on the cover "Tender for Timber Jetty," must be addressed to the General Manager and delivered to him not later than Noon on Monday, the 10th day of December, 1923.

The Commissioners do not bind themselves to accept the lowest or any Tender.

By Order,
ALBERT BLACKLOCK,
Secretary.
Tyne Improvement Commission Offices,
Bewick-street, Newcastle-upon-Tyne,
20th November, 1923. 4186

Tyne Improvement Commission.
ELECTRIC MOTORS AND ACCESSORIES.

The Tyne Improvement Commissioners are prepared to receive TENDERS for the CONSTRUCTION and DELIVERY of 13 SETS of D.C. ELECTRIC MOTORS and ACCESSORIES, about 4½ H.P., each with Worm Reduction for Driving Dock Gate Winches.

Copies of the form of Tender, conditions of contract, specification, and drawing may be obtained on application to the undersigned on payment of a deposit of One Guinea, which will be returned on receipt of a bona fide Tender.

Tenders, in sealed envelopes, endorsed on the cover "Tender for Electric Motors and Accessories," must be delivered at the undermentioned offices, addressed "The General Manager, Tyne Improvement Commission," not later than Saturday, the 1st December, 1923.

The Commissioners do not bind themselves to accept the lowest or any Tender.

By Order,
ALBERT BLACKLOCK,
Secretary.
Tyne Improvement Commission Offices,
Newcastle-upon-Tyne,
21st November, 1923. 4195

PUBLIC NOTICES

Tyne Improvement Commission.
LOCOMOTIVE SHED AT ALBERT EDWARD DOCK, NORTH SHIELDS.

The Tyne Improvement Commissioners are prepared to receive TENDERS for the CONSTRUCTION of a STEEL SHED for LOCOMOTIVES at their Albert Edward Dock, North Shields.

Copies of the form of Tender, conditions of contract, specification, and drawings may be obtained on application to the undersigned on payment of a deposit of Two Guineas, which will be returned on receipt of a bona fide Tender.

Tenders, in sealed envelopes, endorsed on the cover "Tender for Locomotive Shed," must be delivered at the undermentioned offices, addressed "The General Manager, Tyne Improvement Commission," not later than Saturday, the 1st December, 1923.

The Commissioners do not bind themselves to accept the lowest or any Tender.

By Order,
ALBERT BLACKLOCK,
Secretary.
Tyne Improvement Commission Offices,
Newcastle-upon-Tyne.
21st November, 1923. 4194

The Madras and Southern MAHRATTA RAILWAY COMPANY, LTD.

The Directors are prepared to receive TENDERS for :
4 LOCOMOTIVE ENGINES and TENDERS (Broad Gauge), viz.:
TWO 4-6-2 SUPERHEATED PASSENGER LOCOMOTIVES, and
TWO 2-8-2 SUPERHEATED GOODS LOCOMOTIVES,
in accordance with the specification, which may be seen at the offices of the Company. The charge for the specification is One Guinea, which will not be returned. Tenders must be sent in, addressed to the SECRETARY, not later than 2 p.m. on Tuesday, 18th December, 1923, and marked "Tender for Locos."

The Directors do not bind themselves to accept the lowest or any Tender.

Company Offices :
25, Buckingham Palace-road,
Westminster, S.W. 1.
21st November, 1923. 4182

On Thursday, January 3rd, 1924, the NEDERLANDSCHE HANDEL-MAATSCHAPPIJ (Netherlands Trading Society), at Amsterdam, will invite TENDERS for the CONSTRUCTION of High-voltage and Low-voltage Current ELECTRIC PLANT for their new building there.

As from November 19th next copies of the specification and drawings may be obtained on application at the office of the Company, Heerengracht 452, Amsterdam, against payment of 35f.

The Engineers : C. D. NAGTGLAS VERSTEEG, G. KRONER.
The Architects : K. P. C. DE BAZEL, A. D. N. VAN GENDT.
P8853

Madras and Southern Mahratta RAILWAY COMPANY, LIMITED.

An ASSISTANT LOCOMOTIVE SUPERINTENDENT is REQUIRED for service on the Company's staff in India.

Candidates must be of non-Asiatic descent, unmarried, and not more than 35 years of age, and the further qualifications desired are as follows :—

A public school education, at least three years' pupilage in the loco. shops of a British railway company or loco. builder, one year in the drawing-office and an engineering degree or diploma from a recognised Engineering College. Some running experience is also desirable.

STARTING SALARY.—According to age and qualifications, with a maximum of Rs. 625 per mensem, rising according to the rules in force.

TERMS.—Subject to a strict medical examination by the Company's Consulting Physician, a three years' agreement in the first instance, a first-class free passage to India and home again on satisfactory termination of agreement, which is extensible by mutual consent. Employees are required to subscribe one month's pay yearly to the Company's Provident Fund, and to those of over five years' service a bonus equal to their contribution is credited, both bonus and contributions accumulating at compound interest until retirement.

Applications should be made in the first instance by letter only to the undersigned, giving details in chronological order with dates of general and technical education and practical experience. Special forms of application, which must be returned by 10th December, 1923, will be sent to applicants who appear to have the necessary qualifications.

SECRETARY,
Madras and Southern Mahratta Railway,
25, Buckingham Palace-road, S.W. 1. 4190

PUBLIC NOTICES (continued) Page 2.

SITUATIONS OPEN, Page 2.

SITUATIONS WANTED, Page 2.

PARTNERSHIPS, Page 2.

PATENTS, Page 2.

MACHINERY, &c., WANTED Page 2.

FOR SALE, Pages 2, 3, 4 and 100.

AUCTIONS, Pages 3 and 100.

PREMISES TO LET OR WANTED Page 3.

WORK WANTED, Page 4.

MISCELLANEOUS, Page 2.

For Advertisement Rates see Page 561, Col. 1.

NUMERICAL INDEX TO ADVERTISEMENTS, Page 99.

PUBLIC NOTICES

The Great Indian Peninsula RAILWAY COMPANY.

The Directors are prepared to receive written APPLICATIONS from duly qualified candidates for the undermentioned POSTS, to be filled in connection with the Company's Workshops in India :—

(A) ASSISTANT STORES SUPERINTENDENT.
(B) ASSISTANT WORKS MANAGER—RELIEVING.
(C) ASSISTANT TRANSPORTATION SUPERINTENDENT.

TERMS.—The appointments are for 3 years under agreement in the first instance, which may be subsequently extended by arrangement. The Company will provide first-class passages to India.

SALARIES.—The salaries of the respective appointments will fall within the following limits :

Assistant Stores Superintendent : Rs. 800 to Rs. 1300 per mensem.
Assistant Works Manager—Relieving : Rs. 600 to Rs. 1150 per mensem.
Assistant Transportation Superintendent : Rs. 450 to Rs. 1150 per mensem.

The initial salaries will ordinarily be the minimum of the scale notified against class of appointment, but may be higher if specially qualified men are selected. Increases of salary will be in accordance with the incremental scale which may be seen in the Company's office. Increments are granted after each year of approved service up to the maxima stated above.

Leave will be granted at the discretion of the Company in accordance with the rules. Leave cannot be claimed as a right. The Leave Rules may be seen in the Company's office.

GENERAL QUALIFICATIONS.—Candidates should be between the ages of 28 and 40 for appointments (A) and (B), and between 25 and 35 for appointment (C), and should have had a first-class education and subsequent training as a Mechanical Engineers in Railway or Manufacturing Workshops.

ASSISTANT STORES SUPERINTENDENT (A).
In addition to having received a Mechanical Engineer's training, the candidate should be conversant with modern workshops practice and have a thorough knowledge of stores organisation as applied to Manufacturing and Repair Workshops. The successful candidate, whilst on the cadre of the Stores Department and remaining under the Chief Stores Superintendent for discipline and methods of procedure, would be attached to the Department of the Chief Mechanical Engineer for service in connection with the Workshop Stores, into which he would be required to introduce up-to-date methods of procedure both from the technical and commercial standpoint.

ASSISTANT WORKS MANAGER—RELIEVING (B).
Should preferably have received his training and held administrative positions in a Railway or Locomotive Builders' Workshops. As relieving officer he would be called on to carry out the duties of the various officers on the Works Manager's cadre on their proceeding on leave, and it is therefore desirable that the successful candidate should have had a very general administrative experience in Engineering Workshops.

ASSISTANT TRANSPORTATION SUPERINTENDENT (C).
Should have received a regular apprenticeship in Railway or Locomotive Builders' Workshops and had subsequent experience in running shed and footplate work. It is desirable that the candidate should have some knowledge of telephonic traffic control and should be acquainted with the block system of signalling and the principles of interlocking of points and signals. Preference will be given to candidates who, in addition to the above, have some electrical knowledge. Candidates should preferably be unmarried.

The selected candidates would be required to pass a strict medical examination by the Company's Consulting Physician before appointment.

Forms, upon which applications must be made, may be obtained on written request (mentioning particular appointment to be applied for) to Messrs. ROBERT WHITE and PARTNERS, 3, Victoria-street, London, S.W. 1, the Consulting Engineers to the Company, and to whom the forms must be returned on completion.

With the application forms will be sent brief particulars of the Railway Provident Fund. 4183

SITUATIONS OPEN

WILL APPLICANTS Who Answered No. 3873 kindly NOTE that this POSITION has now been FILLED. 4160 A

WANTED, First-rate DESIGNER of HORIZONTAL GAS ENGINES, able to make own drawings if necessary, also to improve and bring up to date present designs. Knowledge of producers beneficial, not essential. State age, full particulars of experience, and salary required.—Address, 4174, The Engineer Office. 4174 A

WANTED in Chartered Patent Agent's Office, an experienced TECHNICAL ASSISTANT ; good draughtsman and used to meeting objections, searching and general practice.—Address, stating age, experience, and salary required, P8330, The Engineer Office. P8330 A

WANTED, QUARRY MANAGER, for Large Road Stone Quarries in the West Midlands. Commencing salary £500 to £600 per annum. With thorough knowledge of Crushing and Tar-macadam Plants and General Mechanical and Engineering ability.—Address, stating experience, with copies of three recent testimonials, P8317, The Engineer Office. P8317 A

ASSISTANT TANK FARM SUPERINTENDENT REQUIRED for the East, with experience in Tank Erection and in the Construction of Large Tank Farms. Must be of good organising ability, able to control European staff (erectors) and native labour, and carry out work economically. Salary according to qualifications. Three years' agreement and free passage out and home. Free furnished bachelor quarters, but not messing.
Age not over 35.
Write, with full particulars and copies of testimonials, to Box A, c/o The Regent Advertising Service, Ltd., 4, London Wall-buildings, London, E.C. 2. P8306 A

CHIEF ESTIMATOR and RATE FIXER REQUIRED for Machine Tool Works working on straight piecework system. Only those who have thoroughly up-to-date knowledge of Machine Tool Manufacture need apply.—Apply, in own handwriting, giving age, salary expected, and at least two references, to ALFRED HERBERT, Ltd., Edgwick Works, Coventry. 4063 A

CONTRACTORS' CIVIL ENGINEER, Age 35 to 40, REQUIRED for Tropics.—Full particulars of experience and references required.—Write, Box 115, c/o Dawson's, 17, Craven-street, London, W.C. 2. [4157 A

ENGINEER (WORKING), 29 to 30 Years of Age, WANTED as "WORKS ASSISTANT" in Paper Coating Works ; must have some knowledge of Photography, fairly educated, experienced, business habits, good credentials ; in confidence.—Address, P8351, The Engineer Office. P8351 A

ENGINEER WANTED, with Experience and Good organising ability, to Superintend Erection of a Large Industrial Works and Apparatus. State age, experience, and salary expected.—Address, P8357, The Engineer Office. P8357 A

REQUIRED by Engineering Firm in the North of England, ELECTRICAL ENGINEER, with experience in the Design of Heavy-duty and Traction Motors.—Address, giving full particulars of qualifications, experience, and salary required, P8355, The Engineer Office. All applications will be treated with strict confidence. P8355 A

WANTED, First-class LEADING DRAUGHTSMAN, accustomed to high-class Colliery Machinery. Give details of experience, also age and salary.—WALKER BROS. (Wigan) Limited, Pagefield Ironworks, Wigan. 4158 A

DRAUGHTSMAN REQUIRED, Engineering Firm in City, used to Piping Lay-outs ; only experienced man need apply.—Address, 4192, The Engineer Office. 4192 A

DRAUGHTSMAN (SENIOR) REQUIRED, Thoroughly experienced in Designing and Detailing all types of Structural Steel Work.—Address, stating age, experience, and salary required, 4161, The Engineer Office. 4161 A

DRAUGHTSMEN. — SEVERAL FIRST-CLASS DRAUGHTSMEN REQUIRED for Aeroplane Design. Must be capable section leaders with previous experience of carrying out complete design of components. State full particulars of experience, age, and salary required, to THE H. G. HAWKER ENGINEERING COMPANY, Ltd., Kingston-on-Thames. 4138 A

DRAUGHTSMAN, Thoroughly Experienced in General Engineering, particularly with reference to Lay-out of Plants. Previous experience in Central Station Work desirable, but not essential. N.J.B. working conditions : Class F, Grade 9A (approx. £344 at present).—Applications, stating age, training, and experience, accompanied by copies of recent testimonials, to be endorsed "Draughtsman," and sent to Major H. BELL, City Electrical Engineer and Manager, Sculcoates, Hull. 4167 A

DRAUGHTSMAN, with Thorough Knowledge of Design of Locomotive Steam Cranes. State age, experience, salary required, and when at liberty.—Address, 4196, The Engineer Office. 4196 A

FIRST-CLASS DRAUGHTSMAN WANTED by important Firm. Must have recent experience in Design of Pumping Machinery. This is a good opening for a capable and progressive man.—Address, stating full experience, age, and salary required, 4200, The Engineer Office. 4200 A

FIRST-CLASS DRAUGHTSMAN for the North of England. WANTED, a man with sound experience of Cement and Crushing Plants, who is capable of undertaking the design of the machinery and general lay-out of such plants.—Address, giving details of experience, age, and salary required, 4178, The Engineer Office. 4178 A

FIRST-CLASS STRUCTURAL DRAUGHTSMEN REQUIRED ; none but experienced men need apply. State full particulars, age, salary required.—THE CLEVELAND BRIDGE and ENGINEERING CO., Ltd., Darlington. 4076 A

STRUCTURAL DRAUGHTSMAN (Junior) REQUIRED for S.W. London. Experience in Detailing Light Structural Work essential. State experience, age, and salary.—Address, P8347, The Engineer Office. P8347 A

WANTED for Large Works in S.W. Lancashire, BUILDING CONTRACTORS' FOREMAN, capable of supervising the lay-out and erection of Factory Buildings. Must have a varied experience of labourers', erectors', brick setters', and joiners' work. State age, experience, and wages required.—Address, 4162, The Engineer Office. 4162 A

WANTED, First-class WOOD TEMPLATE MAKERS, accustomed to Bridge and Structural Work. Society men required.—SIR WILLIAM ARROL and CO. (Swansea), Ltd., Kings Dock, Swansea. 4054 A

SITUATIONS WANTED

ENGINEER, B.Sc., Lond., Wide Experience in plant work, all classes of power, furnaces or general, DESIRES IMMEDIATE POST with prospects of permanency.—SEARS, Trevone, Billericay, Essex. P8341 B

ENGINEER (22) DESIRES APPOINTMENT Abroad or home, preferably abroad. Thorough knowledge of internal combustion engine design and installation (levels and setting out, &c.), including 3 years works, 3 years drawing-office, nearly one year commercial sales ; Student Inst. C.E. and M.E., and Graduate, Inst. Struct. E. ; articled pupil.—Address, P8338, The Engineer Office. P8338 B

ENGINEERS AND CONTRACTORS.—GRADUATE, 1st Class, Civil Engineering (Liverpool), WANTS JOB, home or abroad ; moderate wages, capable, has good knowledge of working men.—Address, P8339, The Engineer Office. P8339 B

HYDRAULIC PRESS and HAMMER FORGE MANAGER, with practical and technical experience in the manufacture of all classes of ship forgings, locomotive work, gun forgings, and general commercial work, heavy and light, in various brands of carbon and alloy steels, DESIRES POSITION. Good draughtsman and estimator.—Address, P8310, The Engineer Office. P8310 B

MACHINE and ERECTING SHOPS MANAGER SEEKS POSITION (age 36) ; 12 years' experience in charge, fully experienced in estimating and working to estimates ; two years' rate-fixing experience, successful record, good references.—Address, P8332, The Engineer Office. P8332 B

MECH. ENGINEER, 1st Class B.O.T., Experience includes Diesels, steam turbines, electricity, refrigeration, water-tube boilers, mining and ore crushing machinery, factory maintenance and workshop practice.—Address, P8342, The Engineer Office. P8342 B

M.I. MECH. E. OPEN, on Completion of Agreement, for POST, home or abroad. Twenty years' experience (ten years N. America) in design, construction, and installation of power, refrigeration, materials handling, crushing and grinding plants, ferro-concrete and steel design and construction, works management and commercial experience.—Address, P8246, The Engineer Office. P8246 B

QUALIFIED ENGINEER (33), 1st Class B.O.T. Certificate, 18 years' practical experience, marine, mechanical, electrical, refrigerating, laundry, DESIRES APPOINTMENT (home or abroad), installation, maintenance or works.—L., 16, Coniston-avenue, Wallasey, Cheshire. P8348 B

RLY.-TRAINED ENGR. (Theo. and Prac.), Used to controlling men, DESIRES POSITION with large colliery or similar firm as Loco. and Wagon Manager. Capable of assuming entire responsibility for the design, construction, and maintenance of all types of rly. locos. and wagons. Good all-round experience and excellent references.—Address, P8316, The Engineer Office. P8316 B

SECRETARY - ACCOUNTANT, COMMERCIAL MANAGER or FACTORY COST ACCOUNTANT DESIRES POSITION with MOTOR or ENGINEERING MANUFACTURING CO. Capable of taking control of existing methods or of organising thoroughly efficient system of COST and General Accountancy, giving MONTHLY DEPT. and General Trading, P. and L. a/cs. and Balance Sheet ; supervision of establishment charges, control of stocks, and work in progress and accurate costing.
Address, P8339, The Engineer Office. P8339 B

YOUNG CIVIL ENGINEER (22), Public School, Stud. Inst. C.E., ex-Service, Diploma (equivalent to B.Sc. Eng.), short D.O. experience, DESIRES OPENING anywhere. Small salary.—Address, P8334, The Engineer Office. P8334 B

ENGINEER and DESIGNER (38), with Progressive ideas and initiative, DESIRES CHANGE ; 1st Class B. of T. Cert., thorough practical and technical experience in marine, mech. and general engineering, fluent French, good tech. correspondent ; at present head of experimental dept. in London.—Address, P8354, The Engineer Office. P8354 B

CHIEF DESIGNER, 35 (Swiss), Scientific Instruments and high precision machinery, fully conversant with modern methods and able to take control of works and D.O., DESIRES CHANGE ; 9 years present position in London. Highest refs. ; fluent French.—Address, P8352, The Engineer Office. P8352 B

SITUATIONS WANTED (continued)

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For continuation of For Sale Advertisements see page 3

A Seven-Day Journal

The Light Cruiser Programme.

In the course of his election address, issued on Saturday, the Prime Minister, dealing with the position of the shipbuilding industry and the efforts to be made by the Government to give it special assistance by accelerating the programme of light cruiser construction, revealed the fact that that programme embraces the building of a considerably larger number of vessels than had been generally anticipated. The Government's naval advisers, Mr. Baldwin stated, were of the opinion that some seventeen light cruisers would be required during the next few years in replacement of the "County" class in addition to a variety of smaller and auxiliary craft. He added that it was intended to lay down a substantial proportion of these vessels as soon as the designs were ready and parliamentary sanction had been obtained. As was suggested in a leading article in last week's issue, the vessels will probably have a displacement of about 10,000 tons and cost some million and a-half sterling. The programme will thus involve, apparently, the expenditure of round about twenty-five million pounds.

Settlement of the Boilermakers' Dispute.

The adjourned conference between the representatives of the Shipbuilding Employers' Federation and the Boilermakers' Society, which opened at Edinburgh on Wednesday of last week, was continued on Thursday and Friday. On the evening of the third day the welcome news was officially forthcoming that an agreement had been arrived at in settlement of the dispute. The basis of the agreement is, briefly, as follows:—The two parties are to consider in committee how far the national overtime and night-shift agreement at five particular points reveals anomalies requiring correction or special circumstances peculiar to the boilermakers needing adjustment. Should the Committee fail to agree, the points of difference are to be submitted to the Industrial Court, the boilermakers, in the meanwhile, accepting and operating the terms of the agreement as it stands at present. The boilermakers' delegates agreed to recommend their Society to accept these terms. The proposals have still to be ratified by ballot among the men. That ballot was taken on Tuesday, Wednesday and Thursday of this week, and from the reports received from all centres there can be little doubt that it will be found to show a substantial majority in favour of the settlement. Work will be resumed on a date to be settled in mutual agreement by the Federation and the Society after the result of the ballot has been declared. Thus, after seven months of disastrous idleness, the boilermakers are returning to work on terms which, as is nearly always the case in industrial disputes, seem to be little, if at all, different from those which might have been arranged in the early days of the struggle.

Trade Facilities Act.

Under the Trade Facilities Act, the Treasury has just given guarantees in connection with some new loans aggregating nearly £3,500,000, bringing the total loans so guaranteed up to about £29,500,000. Included in the new loans are one for £1,500,000 to the North Wales Power Company for the carrying out of a hydro-electric scheme; another for £150,000 to the Tata Power Company for a scheme of a similar nature in India, and a third for £1,800,000 to the Bank Line for the construction of motor ships. The Bank Line, the managing owners of which are Andrew Weir and Co., of London, will soon have twenty-one motor ships under construction or in hand. All, it is understood, are to be built at Govan by Harland and Wolff, and will be equipped with engines of the design associated with the name of that firm and Burmeister and Wain.

A Catalogue of Old Books.

The annotated catalogues of old, rare and standard works on exact and applied science, issued by Henry Sotheran and Company, the well-known booksellers of the Strand and Piccadilly, London, are always interesting and in themselves of considerable value to the student of antiquarian science. A sectional catalogue we have recently received now lies before us. It deals with astronomy, astrology, chronology, geodesy, horology and dialling. One of the entries describes a star atlas compiled by John Bevis, or Bevans, a London medical practitioner, who flourished in the first half of the eighteenth century. This work was never published in the proper sense, for in 1750, when it was ready for the press, John Neale, the publisher, became bankrupt, and the fifty-two engraved plates prepared for it were sequestered by the Court of Chancery. Had the atlas duly appeared, it would have been the fifth printed in order of chronology, previous atlases having been published by Bayer (1603), Cellarius, Doppelmayer and Flamsteed. Although it was well known that Bevis had prepared an atlas, the fact that a copy of it had been printed and was actually in existence was quite unsuspected. How what is believed to be probably the only copy of it came into Messrs. Sotheran's hands we are not told. But there it is, and there it presumably will remain until someone is willing to acquire it by parting with the sum of £250. If that price seems high we cannot say the same of the sum of twelve guineas, which is all we are asked to pay for the rare original edition of Tycho Brahe's collected astronomical writings, which edition was largely printed by the Danish philosopher himself with his hand press, at Uraniborg, and finished at Prague in 1603. Nor is 15s. a large sum to pay for the first edition—1728—of Newton's "Chronology of Ancient Kingdoms Amended," in which he sought to verify or to correct by astronomical means the chronological points of history from "the first memory of things in Europe to the conquest of Persia." In preparing this work Newton apparently derived much help from Sir John Marsham's "Canon Chronicus," published in 1676. The great philosopher's own copy of that work, with many of its pages, "turned down in Newton's naughty but characteristic manner," is offered by Messrs. Sotheran for two guineas.

The Institution of Engineering Inspection.

In his presidential address, which he delivered before the Institution of Engineering Inspection on Monday last, Mr. Francis R. Wade said that he thought that the activities of the Institution might soon be guiding the futures of the various branches of engineering enterprise in this country and, possibly, throughout the world as well. For many years, he remarked, the engineering profession had been constantly subdividing itself, vertically, into groups and sections as the uses for engineering skill multiplied. The Institution had been rightly termed the horizontal inter-section of all those vertical subdivisions and sections of engineering. One of its main objects was to standardise the methods adopted by those whose duty it was to see that only really good work was sent out from our factories, so that its quality could always be implicitly relied upon. A very great responsibility rested on the shoulders of the inspection engineer, who might be regarded as the guardian of the safety of mankind.

The Industrial Welfare Society.

The fifth annual general meeting of the Industrial Welfare Society was held in London on Wednesday. The Duke of York, President of the Society, said that the desire to give fuller recognition to human values in industry had for many years produced its worthy exponents, and they gave ungrudging honour to those pioneer students of the new science of what had been termed "Industrial Humanics." The Society owed its existence to the need for some organisation to give fresh impetus to the ideas underlying the welfare movement, to enlarge the old conception of the duty of the employer towards his workers, as well as the responsibilities of the workers towards their employer, to rekindle sympathies which might have been forgotten in the race for material prosperity, to show how difficulties could be removed and better understanding created. They were confident that in the mining centres, the shipyards, the factories and mills where welfare schemes had been introduced nothing but good had resulted. "In such places," continued the Duke, "very real human relations are being built up, and a spirit of mutual understanding is being created, and I am not sure that in the end we shall not find that simple human feelings will solve many of the problems which have baffled our industrial leaders for many a long year."

The "Underground" Extension to Hendon.

On Monday afternoon the London Electric Railways Company opened its extension from Golders Green to Hendon, Central, together with an intermediate station at Brent. The new portion of railway is 1.63 miles in length. The first sod was cut by Sir Philip Lloyd Greame, now the President of the Board of Trade, and the contract was let to Charles Brand and Son, the firm which is widening the portion of the City and South London tunnel lying between the Angel and Euston. The work includes, in addition to the two new stations at Brent and Hendon, an enlargement of the Golders Green Station, a fine girder bridge across the Golders Green-road, and a viaduct, 30ft. high, over the river Brent. An extension, 3.05 miles in length, is also under construction forward to Edgware, with intermediate stations at Colindale, 1.31 miles, and at Burnt Oak, 2.21 miles from Hendon. From the terminus at Edgware to that at Clapham Common will be 16.44 miles, which will be covered, without any change of carriage, in 49 min.

Vessels Lost, Condemned, &c.

The Returns of Lloyd's Register of Shipping of the vessels totally lost, condemned, &c., in the three months from April 1st to June 30th last, which have just been published, show that—excluding cases of breaking up, condemnation, &c., which are not known to be consequent upon stress of weather, &c.—a total of 74 vessels, with an aggregate of 100,820 tons, were affected. Including cases not known to be consequent upon stress of weather, &c., the totals become 176 and 382,045 tons respectively. Of the 74 vessels, 29 were propelled by sails and 45 by steam or motor. The greatest losers in point of numbers were the United States with 18—8 power and 10 sailing; the British Dominions, 12—2 power and 10 sailing; and Great Britain and Ireland, 10—all power driven. As regards tonnage, however, Great Britain and Ireland take first place with a total loss of 35,842 tons; the United States coming second with 22,310 tons, and the British Dominions third with 7106. The fourth place is taken by Norway with 6 vessels, all power driven, of a total of 5750 tons. In terms of percentage, Great Britain and Ireland lost 0.12 per cent. of vessels owned and 0.19 per cent. of tonnage owned, the figures for the British Dominions being 0.11 and 0.14 respectively, for the United States 0.21 and 0.11 respectively, and for Norway 0.36 and 0.24 respectively. No single country, other than those mentioned, lost as much as 4000 tons, the next in order of tonnage loss being Holland, which lost 2 vessels with a combined total of 3627 tons, and Denmark, which lost 1 vessel of 3297 tons.

Railway Labour.

On Friday of last week, the National Wages Board concluded its inquiry into the application of the railway companies for a modification in the conditions of service of the men. Since Wednesday, the representatives of the unions had been stating their answer. Mr. C. T. Cramp replied on behalf of the National Union of Railwaymen; Mr. J. Bromley for the Associated Society of Locomotive Engineers and Firemen, and Mr. A. G. Walkden for the Railway Clerks' Association. Mr. Clower afterwards replied for the companies. Judging by past experience the award may be expected any day, but it is important to remember that its acceptance is not obligatory. Contrary to expectation, no indication was given as to the present financial condition of the companies. It was admitted that the sliding scale reduction saved the companies £55,000,000 a year. Against this saving must be offset the reductions in rates and fares that have been made, and the fact that the wages bill is still £70,000,000 a year over that of 1913.

New Chief Engineers, Great Western Railway.

As was announced in our issue of September 28th Mr. W. W. Grierson, chief engineer to the Great Western Railway Company, retires from that position on December 31st, but has consented to act as consulting engineer to the company. From January 1st, Mr. J. C. Lloyd and Mr. W. Waddell are to be joint chief engineers. The former gained some of his earliest experience in railway engineering at Plymouth under Mr. P. J. Margary and, later, under Mr. T. H. Gibbons, in the renewal of some of the timber viaducts in Cornwall and the re-arrangement of the roads and connections to suit the conversion in the Plymouth division from the broad and mixed gauges to the standard gauge. He subsequently held important positions in the Bristol and Gloucester divisions, and went to Neath—where, under his father, he had begun his railway career—as divisional engineer in 1911, and to Reading in 1919 to succeed the late Mr. G. E. Louth as permanent-way assistant to the chief engineer, which position he now leaves. Mr. Waddell has always been associated with the Barry Railways and Docks. He was engaged with Sir John Wolfe Barry in their construction, and, afterwards, was for a time employed on the subsidiary undertaking—the Vale of Glamorgan Railway—later becoming an assistant to Mr. James Bell, the railway company's engineer, and eventually succeeding that gentleman. Mr. Waddell was subsequently one of the few chief engineers who became general managers. On the amalgamation of the Barry with the Great Western, he became docks assistant to the chief engineer.

The Faraday's Maiden Voyage.

The new cable-laying steamer Faraday, belonging to Siemens Brothers and Co., Limited, of Woolwich, a description of which we gave in our issue of March 16th this year, has now returned from her maiden cable-laying expedition. She has successfully completed the laying of the section of cable connecting New York and Canso, Nova Scotia, a distance of about 1000 miles, notwithstanding the fact that she encountered exceptionally bad weather, during which a mishap occurred to the cable and the end was lost in 3000 fathoms of water. The vessel, on this occasion, proved her excellent qualities as a cable steamer, as the end was recovered very quickly and the whole section completed to the satisfaction of the engineers to the Commercial Cable Company, which company has had it in constant use since it was laid. This section forms a part of the Commercial Cable Company's new connection between America and England, which, it is claimed, has the greatest traffic-carrying capacity of any cable in existence.

Short Histories of Famous Firms.

No. XVII.*

KITSON AND CO., LIMITED, AIREDALE FOUNDRY, LEEDS.

THE original founder of Kitson and Co. was Mr. James Kitson, who, though not trained as an engineer, was a man of great business ability. His previous connections appear to have been with merchants in the iron trade, but towards the end of 1837 he foresaw in the rapid development of railways an excellent opening for the manufacture of machinery and locomotives for the new transport industry. He then entered into partnership with two others and founded the firm of Todd, Kitson and Laird, which began manufacturing early in 1838, as far as can be ascertained. Todd had been trained as as engineer, and Laird appears to have found much of the necessary capital. This early firm was the origin of the Railway Foundry, which was afterwards so well known as E. B. Wilson and Co. Its first engines were the Lion and Tiger for the Liverpool and Manchester Railway, the former of which was delivered in July, 1838, and is still in existence and at work as a pumping engine under the Mersey Docks and Harbour Board at Prince's Dock, Liverpool. These two engines were of the 0–4–2 type, with 11in. by 20in. cylinders, 5ft. coupled wheels, outside "sandwich" framing and boilers of oval section. Four similar, but larger, engines, with 14in. by 20in. cylinders, were built in 1839 for the same railway, and were followed by two 2–2–2 passenger engines, with 6ft. driving wheels for the Paris–Orleans Railway, which were delivered the same year.

But the original partnership did not last long, for in 1839 Messrs. Kitson and Laird withdrew, and Todd continued the existing business with a new partner under the title of Shepherd and Todd of the Railway Foundry. The two engines for the Paris-Orleans Railway, which were ordered from the original firm, appear in the accounts of the railway company as delivered by Shepherd and Todd.

With Mr. Laird, James Kitson then started new works on or near the site of the present Airedale Foundry under the title of Laird, Kitson and Co., and the first wages sheet, amounting to £3 1s. 8d., was paid on May 18th, 1839, to five men who had then worked two to five days. These early wage records were made out in an account book which had belonged to certain Portuguese wool merchants, whose warehouse, contents included, appears to have been taken over.

An interesting punching and shearing machine —Fig. 1—made in the early days by Laird and Kitson, is still in active service in the works. It bears an inscription indicating its capacity—"Punching limit, $^{9}/_{16}$in. diameter by $\frac{3}{4}$in. thick; shearing limit, $\frac{3}{4}$in. thick." The top of the jaw casting is strengthened by a vertical prop, as shown.

The first locomotives, Nos. 1 and 2, were built for the North Midland Railway in 1840, and Nos. 5, 6, 9 and 10 were for the same railway, and with these engines Messrs. Kitson began a long and honourable connection with the Midland, which has continued until the present century. Nos. 3 and 4 were built for the Manchester and Leeds Railway, and 7 and 8 for the York and North Midland Railway. All these engines were of the same general type, 2–2–2 passenger locomotives with outside sandwich frames and Gothic fire-boxes, though they differed in general dimensions. A sheet of early Kitson engines has recently been added to the exhibits at South Kensington Museum, and on it appears a drawing of the York and North Midland engines, which had 5ft. driving wheels and 13in. by 18in. cylinders. Two of the North Midland engines had 6ft. driving wheels and 14in. by 18in. cylinders, and the other engines mentioned had 5ft. 6in. drivers and 13in. and 14in. cylinders. All of them were built to the designs of R. Stephenson and Co., and of the standard types at that time constructed by the latter firm. It may be added that during the first eight years of the firm's existence there appears to have been an intimate connection with Messrs. Stephenson, who, at that time, could not possibly deal with all the orders which reached them, and recommended certain other firms, including Mr. Kitson's, for the work. In 1842 the company was reconstituted with new partners on the withdrawal of Mr. Laird. Mr. Kitson was then joined by Mr. Isaac Thompson, who had been an iron merchant at Northallerton, and by Mr. William Watson Hewitson, whose early training in locomotive engineering had been received at the works of R. and W. Hawthorn, of Newcastle.† From this time, until June, 1858, when Mr. Thompson retired, the title of the firm was Kitson, Thompson and Hewitson.

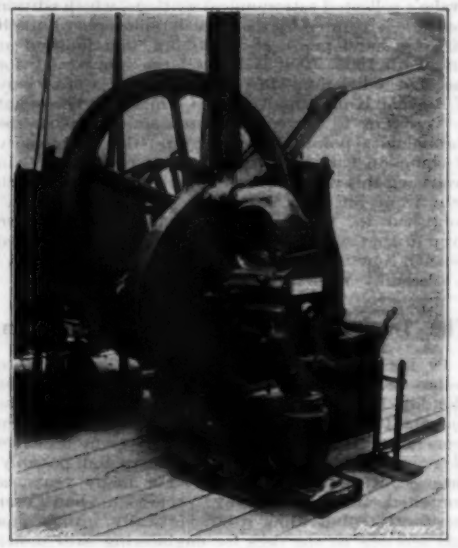


FIG. 1—OLD PUNCHING AND SHEARING MACHINE

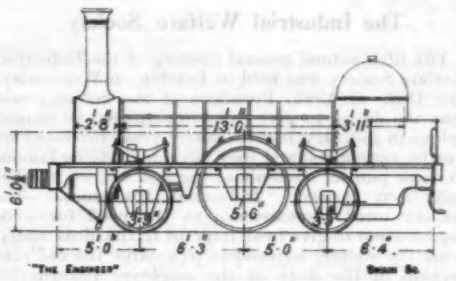


FIG. 2—SINGLE DRIVER ENGINE, MIDLAND RAILWAY, 1845

The first engines which the firm sent abroad were built in 1844 for a German line, the Altona-Kiel Railway. They were 2–2–2 passenger engines of Stephenson's inside cylinder long boiler type, with Gothic fire-boxes and inside bearings throughout. The single driving wheels had a diameter of 5ft. 4in., and the cylinders were 13½in. by 20in. The workmanship must have been very good, for three of them were at work for about forty years, the boilers having been renewed in 1871. Two similar, but larger, long boiler engines with inside cylinders—Fig. 2—with 5ft. 6in. driving wheels, 15in. by 22in. cylinders, and weighing 21 tons 7 cwt. in working order, were built in 1845 for the Midland Railway, one of which, Midland No. 54, figured prominently under Mr. G. P. Bidder's supervision in the Gauge Commissioners' trials. It appears to have performed satisfactorily in the Midland preliminary test runs, but during one of the trial runs between York and Darlington, left the rails and turned over. According to a contemporary newspaper, Mr. Kitson was riding in the train, and as two of the carriages were also overturned, probably had a narrow escape. The type of engine and this accident provided the text for some severe criticisms of the class by Mr. (later Sir) Daniel Gooch, who was watching the trial on behalf of the broad gauge champions. But in fairness it should be stated that the Gauge Commissioners reported that the immediate cause of this accident was a broken joint chair, though they added that there was reason to believe that the engine was somewhat unsteady. Mr. G. P. Bidder, who conducted the trial, was known as "the calculating boy," and his grandson, Lieut.-Colonel Maurice Bidder, afterwards became managing director of Kitson and Co., Limited.

In 1846 Messrs. Kitson exported five passenger engines to France for the Orleans-Bordeaux Railway. These were of the Buddicom "Grand Junction" type, with outside cylinders 14in. by 22in., and outside bearings for the carrying axles.

A very large number of 0–6–0 long boiler engines to Stephenson's inside framed design were built for the Midland, York and North Midland, and other railways between 1845 and 1849, most of which had 4ft. 9in. wheels, and 15in. by 24in. cylinders. The earlier engines of this and other classes had Gothic fire-boxes, but in the later engines of 1848–9, Messrs. Kitson made a departure from the original Stephenson design in substituting semi-circular flush fire-box casings, with tall plain round-topped domes and spring balance safety valves on the middle of the barrels, the fire-box being surmounted by a manhole cover on which the whistle was mounted. This very neat design, but with raised fire-box casing, illustrated on Plate 4 of D. K. Clark's "Railway Machinery" (1855), was, with slight modifications to the whistle mounting, shortly afterwards adopted by Mr. M. Kirtley for the Midland engines and became standard on that railway until 1874.

Two Crampton-type rear-driver express engines of a very unusual design, having 7ft. wheels and 16in. by 22in. outside cylinders, were built for the Midland Railway in 1848. The frames were double, and the driving axle had bearings in both the big end of the connecting-rod working on a crank between them. These engines, which had but a short career, and had disappeared by 1855, are shown on the sheet of drawings at South Kensington Museum, and, therefore, are not illustrated here.

Until the end of 1848 a large number of Messrs. Kitson's engines were of Stephenson's long boiler types, but at this period the firm modified the design of the 0–6–0 goods engine with inside frames by placing the trailing wheels behind the fire-box, thus producing the standard modern British goods engine. This design by Messrs. Kitson was practically contemporary with the similar one by B. Hick and Son, of Bolton. Six fast passenger engines of the 2–4–0 type, built for the Leeds and Thirsk Railway in 1849, showed considerable advance in the design of four-coupled engines at that period. These fine engines, which were fully illustrated in D. K. Clark's "Railway Machinery," Plates 4 to 6, had inside bearings for the coupled axles, and outside bearings for the leading carrying axles. This type of "mixed" framing, which afterwards was so largely adopted by the Midland, Great Western, Great Northern and other leading railways, originated with the Leeds firms. The inside cylinders of Kitson's engines were 16in. by 22in., and the driving wheels, 6ft. diameter, had cast iron bosses. Five of these engines ran until the end of 1880, almost

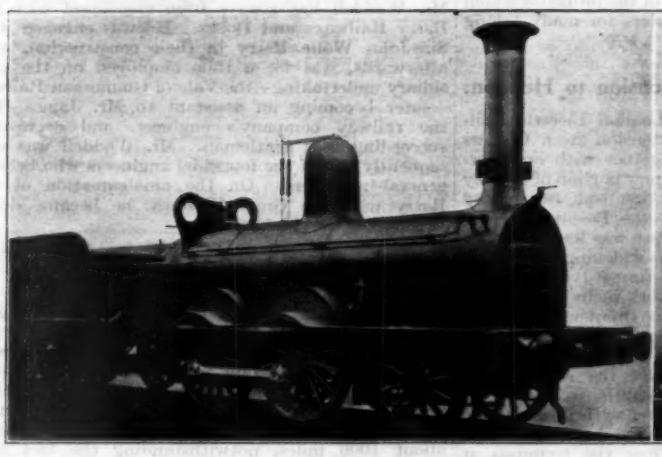


FIG. 3—PASSENGER ENGINE, MADRID AND ZARAGOZA RAILWAY, 1858-9

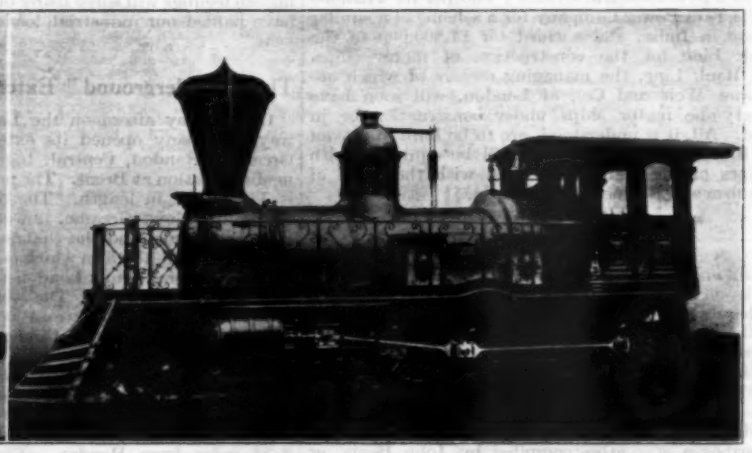


FIG. 4—BOGIE ENGINE, COPIAPO AND CALDERA RAILWAY, CHILE, 1860

* No. XVI. appeared February 2nd, 1923.

† Mr. John Hawthorn Kitson, the third son of Mr. James Kitson, who for many years directed the firm, received his second name after his father's friend, Mr. Robert Hawthorn.

unaltered, on the North-Eastern section between Leeds, Harrogate and Thirsk.

Ten "single" fast passenger engines with 6ft. wheels and 15in. by 22in. cylinders of an enlarged "Jenny Lind" type, having inside bearings for the driving axles, were built in 1850–1 for the North Staffordshire Railway, and for more than thirty years worked most of the faster main line trains on that line. In 1850 the firm constructed two engines for the Taff Vale Railway, thus starting a connection which lasted for many years. Altogether a total of 160 engines were built for this railway, extending over a period of about 55 years. At the 1851 Exhibition Messrs. Kitson had on view a neat tank engine for light passenger trains. This engine, named Aerolite, had outside cylinders 11in. by 22in., and 6ft. single driving wheels. It was afterwards purchased by the Leeds and Thirsk Railway. In 1852 the type of goods engine designed and built by the firm was altered to the double-framed pattern with outside cranks, of which a large number were delivered to the Midland, Great Northern, Manchester, Sheffield and Lincolnshire, and other railways. One of the 1852 engines built for the Midland was still at work in 1922 with the old outside frames after 70 years of hard work.

The first engines sent to India went out in 1854 and consisted of a number of 0–4–2 goods engines for the East Indian Railway. They were followed by "single" express engines for the Madras Railway in 1855, and four coupled passenger engines for the Great Indian Peninsula Railway in 1856. Since then the firm has been almost uninterruptedly engaged upon work for the Indian railways. A connection with Spain was started in 1858–9, when fifteen passenger and fifteen goods engines were delivered to the Madrid and Zaragoza Railway. The passenger engines—one of which is illustrated in Fig. 3—were of the long boiler 2–4–0 type with inside cylinders 16$^{9}/_{16}$in. by 22$^{1}/_{16}$in. and 5ft. 2$\frac{1}{2}$in. coupled wheels. Many of these are still in service.

After the retirement of Mr. Thompson in 1858, the name of the firm was simplified to Kitson and Hewitson, and continued in that form until 1863, when Mr. Hewitson died and the whole of the interests were taken over in 1865 by the Kitson family. The firm then became Kitson and Co., by which title it has since been known. Mr. James Kitson was then joined in partnership by his two sons, Mr. James Kitson, junior, and Mr. John Hawthorn Kitson. The first-named was subsequently better known as Sir James Kitson, Bart., and in 1908 was created a peer with the title of Lord Airedale.

The earliest bogie engines were built in 1858 for the Copiapo and Caldera Railway, Chile. These interesting locomotives, which also had eight-wheeled double-bogie tenders, presented several features of American origin, including the large cab. The connecting and coupling-rods were of circular section, and the dome and whistle mounting were of Kitson's standard pattern mentioned previously. There were four of the class, which had 5ft. 2in. coupled wheels, 3ft. bogie wheels, inclined 16$\frac{1}{2}$in. by 24in. cylinders, and a total heating surface of 1068 square feet. Another 4–4–0 engine—Fig. 4—built in 1860 for the same railway had horizontal cylinders, a large conical chimney with spark arrester, and a highly ornamental balustrade, which enclosed the whole of the platform round the engine.

In 1860–1 the firm built some of the most celebrated single express engines of their day on English main line railways. Of these there were four of Mr. Sturrock's 7ft. 2–2–2 engines—Fig. 5—for the Great Northern Railway. The cylinders were 17in. by 22in., and the leading and trailing wheels had a diameter of 4ft. 3in. The wheel base of 18ft. was extremely long, the leading wheels being placed well forward under the smoke-box, and their springs connected to those of the driving wheels by compensating levers. The boiler was of the domeless type with perforated steam pipe and an extremely long fire-box, which had a longitudinal midfeather, and provided a heating surface of no less than 177 square feet. The total heating surface was 1060 square feet. The inside crank webs were hooped. The total weight of these engines was 34 tons 12 cwt., of which 13 tons 7 cwt. were available for adhesion. These engines rendered excellent service for many years, and after having been re-boilered by Mr. P. Stirling, lasted until 1897–1900.

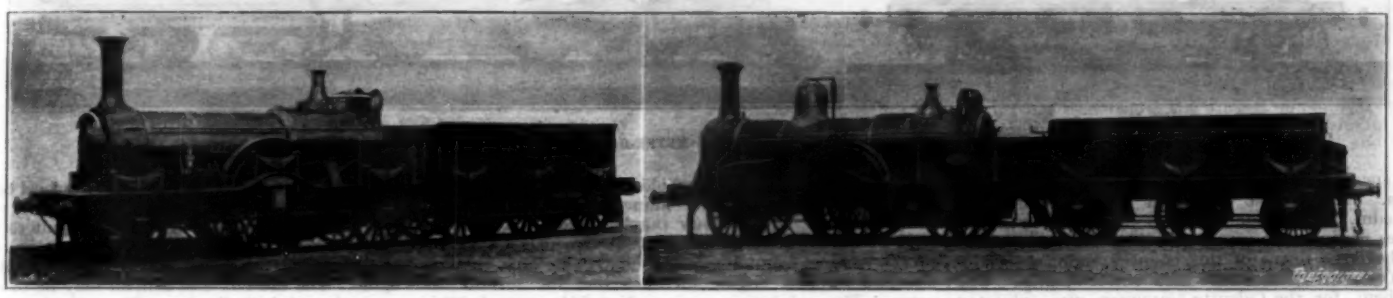


FIG. 5—SINGLE DRIVER ENGINE, GREAT NORTHERN RAILWAY, 1860-1

FIG. 6—SINGLE DRIVER "MAIL" ENGINE, SOUTH EASTERN RAILWAY

Five of Mr. J. E. McConnell's well-known "Bloomer" 2–2–2 express engines with 7ft. wheels and 16in. by 22in. cylinders, similar to those by Sharp, Stewart and Co., were built in 1861, and were followed by four of Mr. Cudworth's almost equally celebrated 7ft. 2–2–2 "Mail" engines for the South-Eastern Railway—Fig. 6. These engines, like those of the Great Northern, had cylinders 17in. by 22in. They were provided with Cudworth's patent double fire-box, which gave a large grate area of 21.2 square feet. The total heating surface was 1137 square feet, and the weight about 33 tons in working order. For nearly twenty-four years these five engines worked the Dover mail express trains over a road by no means easy in regard to gradients, with loads which averaged 135 to 140 tons, and were only taken off these trains in 1884–5, when Mr. James Stirling's 4–4–0 engines replaced them.

The only engines for the Great Western broad gauge which the firm constructed came out in 1862, and consisted of six 2–4–0 outside-cylinder Metropolitan condensing well-tank engines, which were illustrated and described in THE ENGINEER, August 16th, 1895. Similar brief mention may be made of Sturrock's goods engines with steam tenders on the Great Northern Railway, the first ten of which were built by Messrs. Kitson in 1864. These were fully described in THE ENGINEER of January 17th and May 9th, 1917.

Following four 2–4–0 passenger engines exported in 1866 to Egypt, special mention must be made of forty-five 0–6–0 goods engines—Fig. 7—built in 1866–8 to Mr. Matthew Kirtley's designs for the Midland Railway, which have done wonderful service. The cylinders are 16$\frac{1}{2}$in. by 24in., in later years enlarged to 17in. and a few to 18in. diameter. The wheels had a diameter of 5ft. 2in., and the boiler pressure was 140 lb. per square inch. Special attention may be directed to the substantial outside frames, which were slotted out of the solid plate, without, as was so frequently the case, connecting the horn plates by means of bolted tie bars. The result of this solid construction was that a broken or cracked outside frame in this class of engine was almost unknown, and the writer cannot remember ever seeing one of the class with a patched frame. Of these forty-five engines, thirty-two are still doing excellent service after an average of fifty-five years of thoroughly hard work. Ten similar but slightly larger engines of 1870, with 17in. by 24in. cylinders, also remain in service, the cylinders of most of them having been increased to 18in. diameter. In addition to the frames some parts of the old motion of all these engines are still in use, though naturally the boilers have been renewed two or three times.

Between 1867 and 1871 the firm built forty-two 0-4-2 mixed traffic engines for the Scinde, Punjaub and Delhi Railway—5ft. 6in. gauge—now the North-Western State Railway of India. They had 5ft. 6in. coupled wheels and 17in. by 24in. cylinders. The type is now obsolete in India.

To the Paris Exhibition of 1867 the firm sent a very neat 2–4–0 passenger engine, which had 5ft. 6in. coupled wheels and 16in. by 22in. cylinders. The leading axle, which had outside bearings, was provided with axle-boxes with inclined planes, an instance of one of the earliest applications in this country of this method of controlling the lateral movement. This engine, for which a gold medal was awarded, was sold to the London, Brighton and South Coast Railway, and remained at work with the original boiler until 1893. A sister engine, built in 1868 for the Llanelly Railway, saw service on the Great Western until 1907, though in this case a new boiler was fitted in 1894. During 1869—1872 Messrs. Kitson constructed more than ninety engines for various Russian railways, mostly 2–4–0 passenger and 0–6–0 goods engines. One of the former, for the Tambor and Saratov Railway, is shown in Fig. 8.

Considerations of space allow but brief mention of the many types of locomotives built during the period 1870–1880. In 1870 a number of 2–6–0 engines were constructed for the 3ft. 6in. gauge railways of Queensland, and in 1873 the firm built the first 4–4–0 main line tender passenger engines to run on the 3ft. 6in. gauge railways of Japan. In 1873 four passenger engines were exported to the Central Argentine Railway—5ft. 6in. gauge—and a considerable number of 4–6–0 and 2–6–0 tank engines were built from 1875 onwards for the Natal and Cape Government Railways. Twenty-four four wheels coupled passenger and mixed traffic engines were sent in 1874 to the Alsace-Lorraine railways. In 1875 some neat 2–4–0 tank engines with outside cylinders were constructed for the Trinidad railways, on which the type has since remained standard, with the later addition of a leading bogie. In 1878–9 tank engines were exported to Mauritius and Jamaica.

For the home railways many engines were delivered to the Midland, Taff Vale and Lancashire and Yorkshire railways. The earliest of Mr. S. W. Johnson's 4–4–0 express engines on the Midland were built by the firm. These ten engines, constructed in 1876–7, had 6ft. 6in. coupled wheels and 17$\frac{1}{2}$in. by 26in. cylinders, with 140 lb. pressure, and most of them are still at work. One of Messrs. Kitson's designs of 0–6–0 goods engine, with 4ft. 6in. wheels and 17$\frac{1}{2}$in. by 26in. cylinders, was standard on the Taff

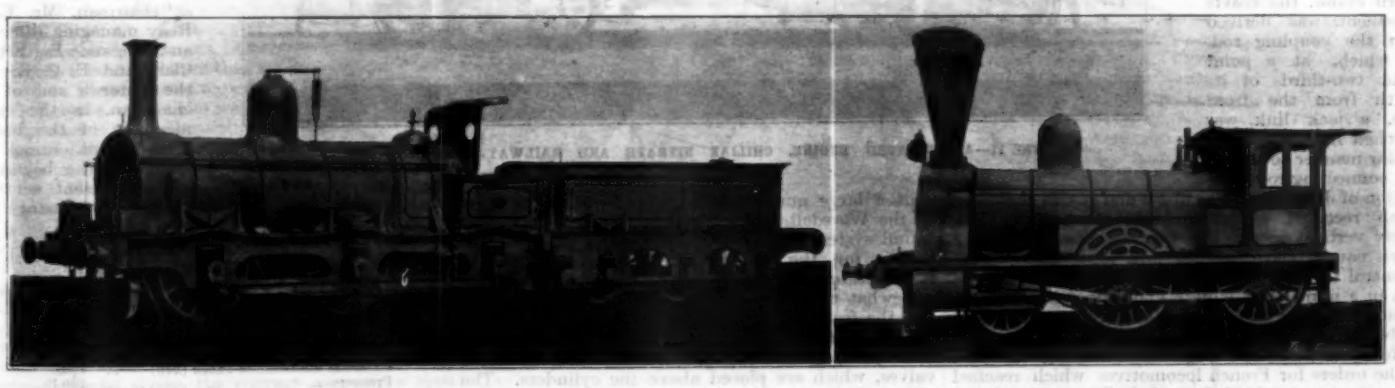


FIG. 7—SIX-COUPLED GOODS ENGINE, MIDLAND RAILWAY, 1866-8

FIG. 8—PASSENGER ENGINE, TAMBOR AND SARATOV RAILWAY, 1869-72

Vale and Lancashire and Yorkshire lines for many years.

In 1876 Mr. James Kitson, sen., retired and the business was transferred entirely to his two sons. His death took place in June, 1885. In January, 1880, the Hon. R. C. Parsons became a partner, and in January, 1885, Mr. Thomas Purvis Reay, who had served his apprenticeship in the works and risen to the position of works manager, was also admitted to partnership. Mr. Parsons retired in 1887.

In 1879 Messrs. Kitson took up the design and manufacture of steam tramway locomotives to replace the horse haulage hitherto in use, and during the succeeding years to 1893 built about 260 of them. The earliest were sent to Canterbury and Dunedin, New Zealand, and to Sydney, New South Wales, but they soon found their way into many of the large towns of this country, more especially in Yorkshire, Lancashire and the Midlands. One of them, for the Calcutta tramways, was exhibited at the Calcutta Exhibition of 1883, and was awarded a gold medal, the highest prize. The tramway locomotives were totally enclosed in a housing, and provided with atmospheric or air-cooling condensers placed on the roof. Additional condensing power was also obtained by means of a tank for occasional or general use when the engines had to be worked on very long and steep gradients. They were also furnished with speed indicators, and in many cases with automatic brakes. They were fitted with Kitson's patented valve gear, which was a modification of the Walschaerts motion, in that the lap and lead movement was derived from the usual crosshead connection through a combination lever, but instead of actuating the slotted quadrant link by means of an excentric or return crank, the travel movement was derived from the coupling rod, to which, at a point about two-thirds of its length from the front axle, a jack link was attached in a somewhat similar manner to that of the connecting-rod connection of Joy's gear. The upper end of this jack link, which received a reciprocating movement in a nearly vertical arc, was in turn attached to a lever which caused the quadrant link to oscillate about a central trunnion. This gear was also used by the firm in a number of colliery and industrial shunting locomotives, and six engines of the Hull and Barnsley Railway in use at Hull Docks are fitted with it.

Messrs. Kitson participated in obtaining part of the orders for French locomotives which reached this country in 1882–3, and built twenty 2–4–0 side-tank passenger engines for the Western Railway of France. These were the first engines of French design to which Ramsbottom safety valves were fitted. A number of 0–6–0 tank engines, built in 1884–5 to Mr. James Manson's design for local traffic on the Great North of Scotland Railway, were the first in this country to be provided with hinged side doors for the footplate to protect the enginemen from draughts. On hearing of this useful improvement, Mr. S. W. Johnson sent an inspector to Airedale Foundry to see the engines, and immediately afterwards had similar doors fitted to all the Midland tank engines.

The 0–6–0 banking tank engines—Fig. 9—of which three were built in 1884 for the Taff Vale Railway, had several special characteristics. They are employed on a gradient of 1 in 13, which is worked by combined wire rope and locomotive haulage. One end of the rope is attached to the engine, which works bunker first up the bank. The rope passes round a heavy pulley at the summit, and the other end is attached to the tail of a descending train on the other road, the weights being balanced as nearly as possible. The cylinders of the engines are 17½in. by 26in., and the coupled wheels have the large diameter of 5ft. 3in., in order to allow the axles to clear the rope, which passes underneath them. The engines push the empty wagons up the bank, and the rope which passes underneath them is attached to a special draw gear underneath the footplate. The boiler is of the "wagon top" design, having a fire-box with sloping top to keep the crown covered with water when ascending the bank. In addition to steam brakes, rail sledge brakes are also fitted between the driving and trailing wheels.

In 1887 the firm designed and built a very handsome 4–4–0 express engine, which, by arrangement with the Manchester, Sheffield and Lincolnshire Railway, was shown at the Manchester Exhibition of that year. This railway purchased it, and the type, of which thirty others were subsequently built, twelve coming from Airedale Foundry, became the standard express engine on that line for several years. The exhibition engine—No. 561—was, for a long time, employed on the London expresses between Manchester and Grantham, on which it did excellent work. The coupled wheels were 6ft. 9in. diameter; cylinders, 18in. by 26in.; boiler pressure, 160 lb., and the total weight about 46 tons. In 1887, and for many subsequent years, the firm built a large number of engines for the Argentine on the Worsdell and von Borries two-cylinder compound system. One of these, a metre-gauge 4–6–0 engine for the North-West Argentine Railway, is illustrated in Fig. 10, and shows a number of somewhat unusual features. To obtain a wide fire-box the frames are placed outside the wheels. The cylinders are outside, but the valve gear is inside, and by means of rocking shafts actuates the slide valves, which are placed above the cylinders. The six-coupled wheels have a diameter of 4ft., the high-pressure cylinder is 16in., and the low-pressure cylinder 23in. diameter, the stroke being 22in. The working pressure is 170 lb., and the total weight in working order 32½ tons.

The 3000th engine, which was sent to the Buenos Aires and Ensenada Railway, was completed in 1887. Six very handsome 2–2–2 express engines, very similar to the type then in use on the Great Western Railway, were built in 1889 for the Egyptian State Railways to the designs of Mr. F. H. Trevithick. They had double frames, inside cylinders 17½in. by 24in., 7ft. single driving wheels, and 140 lb. pressure. For many years these engines worked the most important express trains between Cairo and Alexandria, on which they did excellent work.

No account of the firm would be complete without mention of the well-known Kitson-Meyer articulated locomotives, which it has developed so successfully. This type of engine was suggested to Messrs. Kitson in 1894 by Mr. Robert Stirling,* of the Anglo-Chilian Nitrate and Railway Company, on which line there is a section 17 miles long of 1 in 25 gradient, 75 per cent. combined with curves of 181ft. radius. In the original Meyer design of 1862 the boiler alone is carried on pivots, the water tank and coal bunker being fixed to two steam bogies, but in Messrs. Kitson's development the boiler, together with the tank and bunker, are supported on a pair of girders, which, in turn, rest upon the bogies. There are variations in the design as regards the positions of the cylinders, which in some types are placed at the extreme front and rear of the engine, and in others have both pairs situated immediately behind the respective steam bogies. These differences arise owing to considerations of wheel base, weight distribution, &c. The exhaust from the rear cylinders in many of these engines passes out to the atmosphere through a supplementary chimney at the bunker end, instead of being carried to the front of the engine. The fire-box and ashpan may be of any size required, and the boiler is readily washed out and the ashes easily removed. The girder frame and superstructure are prevented from rolling by plates concentric with each bogie pivot, and from pitching movement by means of slides at the end of each bogie. Kitson-Meyer engines have been made for all gauges from 2ft. 6in. to 5ft. 6in., and are of various wheel arrangements, 0–4–4–0, 0–6–6–0, 2–6–6–4, 2–8–8–0, &c. Our illustration—Fig. 11—shows the engine built for the Chilian Nitrate and Railway Company in 1894. It has the dimensions given in the table below. In 1897, Mr. E. Kitson Clark, a nephew of Lord Airedale, who had entered the works in 1888, and had served as works manager, became a partner in the firm. On the death of Mr. J. Hawthorn Kitson in 1899, the firm was incorporated with Sir James Kitson as chairman, Mr. T. P. Reay managing director, and Messrs. E. Kitson Clark and E. C. Kitson, the latter a son of the chairman, as the other members of the board. That event brings us almost to the beginning of the present century, and at this point we may leave the "history" of the firm.

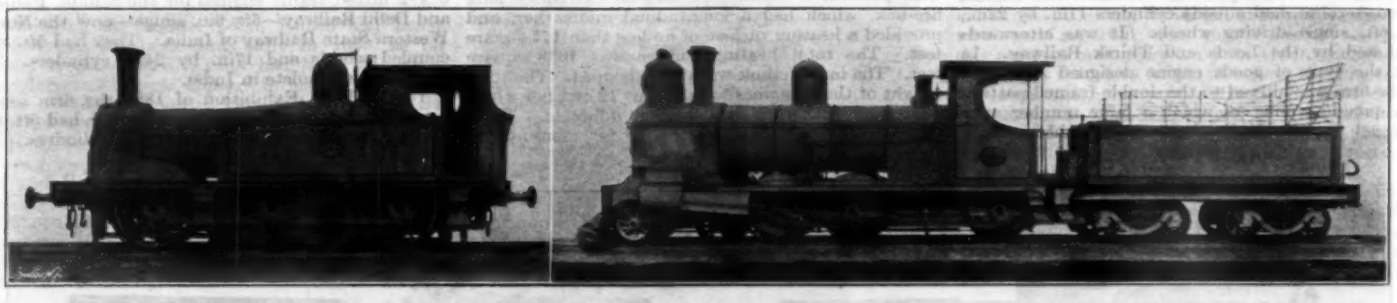


FIG. 9—TANK ENGINE, TAFF VALE RAILWAY, 1884

FIG. 10—METRE-GAUGE COMPOUND ENGINE, NORTH-WEST ARGENTINE RAILWAY

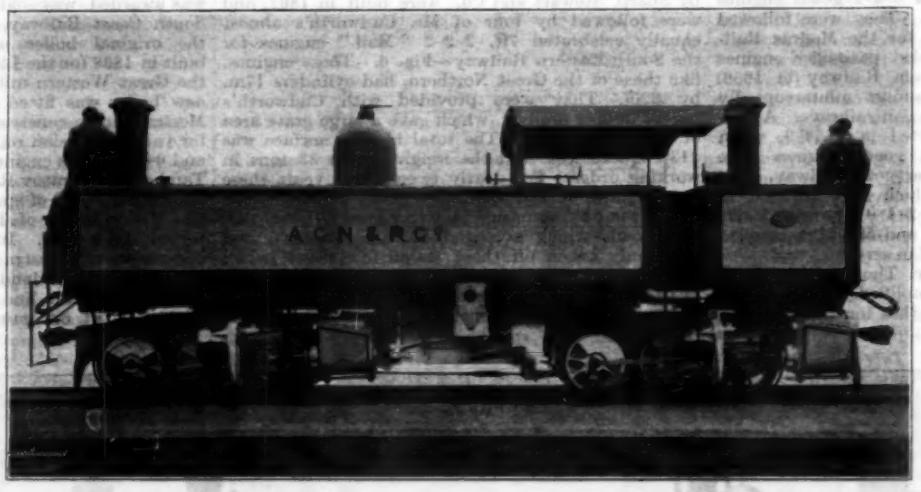


FIG. 11—ARTICULATED ENGINE, CHILIAN NITRATE AND RAILWAY COMPANY, 1894

Particulars of Articulated Engine for the Chilian Nitrate and Railway Company.

Cylinders, four	14in. by 18in.
Wheels, diameter	2ft. 10½in.
Bogie wheel base	6ft. 3½in.
Total wheel base	25ft. 6½in.
Boiler—	
External diameter of tubes (210)	1¾in.
Pressure	160 lb.
Heating surface—	
Tubes	1064 sq. ft.
Fire-box	104 sq. ft.
Total	1168 sq. ft.
Grate area	25.25 sq. ft.
Water capacity	1900 gallons
Fuel capacity, coal	3 tons
Weight, fully loaded	55 tons 7 cwt.
Tractive force	24,000 lb.
Gauge of railway	3ft. 6in.

DURING the three months ended December 31st last, the assistant inspecting officers of railways held thirty-six inquiries into accidents to railway servants, of which eleven related to fatal accidents to twelve servants. Five of the twelve were permanent way men. One other was the case of a lad of eighteen years, employed to open and shut some level crossing gates on the then Great Eastern Railway. They had to be opened about seventy times between 6 a.m. and 6 p.m., and yet were not interlocked with the signals at a signal-box 130 or so yards away. That such interlocking was necessary is shown by the fact that the gates had been run through five times in two years and twice between the date of the accident and when Mr. Main made his report.

* Paper on "Articulated Locomotives," by Lieut.-Colonel E. Kitson Clark. Institution of Locomotive Engineers, October, 1920.

Ship Form and Steering.

By A. W. JOHNS, C.B.E., R.C.N.C., M.I.N.A.

No. I.

THERE are at the present time many excellent text-books on naval architecture from which an inquiring student can obtain a great amount of valuable theoretical knowledge on the subject. The writers of these books generally arrange the matter and describe the methods and processes in an orthodox manner and but rarely depart from it. It is perhaps for this reason that, although the various problems of a ship's stability when she is inclined either about a transverse or horizontal axis are very fully discussed, no mention is made of the stability about a vertical axis when the ship is in motion ahead. This portion of the subject may be termed the stability of motion and deals with the ability of a ship to maintain a straight course without the use of the helm. The behaviour of ships when under the influence of the rudder is generally fully dealt with, but such behaviour is only a portion of the subject. The following notes have been compiled in connection with this generally neglected portion of naval architecture.

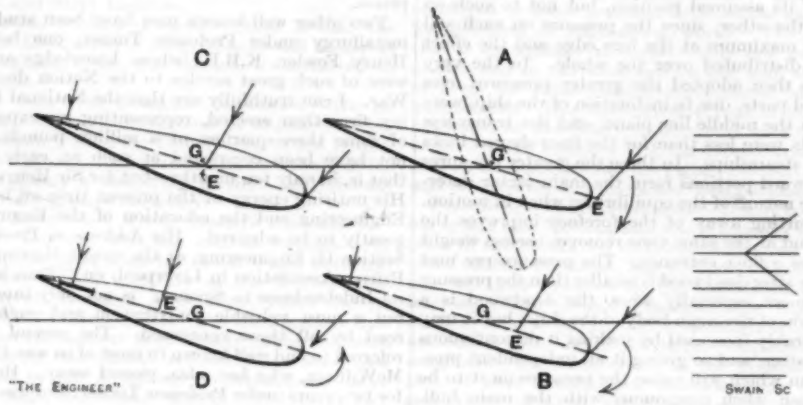


FIG. 1

The equations of motion of a ship when steaming ahead and when slightly inclined to the direction of motion are not difficult to express, but it is impossible to obtain any arithmetical result indicative of the nature of the motion, since so many unknown coefficients are involved. In the case of airships the stability of motion has been dealt with mathematically, and as a result a criterion expression has been obtained from which, by the substitution of arithmetical values for certain quantities, it can be determined if the airship is stable, neutral, or unstable on a course. The quantities referred to vary with every airship, are extremely difficult to explain, and more so to determine by experiment. The conditions obtaining for an ordinary ship are more involved than for an airship, and the solution correspondingly more complicated.

Mathematical treatment being thus of little or no use in the consideration of the problem, it is necessary to turn to the results of experience, and as an introduction to the subject the results of experiments with airship models are well worthy of study.

If a model of the usual cigar-shaped airship in its bare form—that is, without fins, rudders, elevators, cars, &c.—be placed in a uniformly moving current of air, as in a wind channel, with its axis of symmetry parallel to the direction of the current, and a small horizontal angular displacement of the axis be given the model, the latter will move farther away from the displaced position and take up a position of rest across the current with its axis making a considerable angle with the direction of the moving air, *i.e.*, as shown dotted in A, Fig. 1. If the shape were symmetrical about the midship section, it would lie perpendicularly across the current as with a spar floating with a stream.

If, now, small vertical fins are added to the tail of the model and the experiment be repeated, the tendency to turn further from the slightly displaced position of the axis is diminished, and the angle between the axis and the current direction when in the final position of rest will be less than for the bare model.

By gradually increasing the area of the vertical fins the tendency to move from the slightly displaced position continually decreases, until finally a fin area is reached with which the model remains in the displaced position and has no tendency to move from it in either direction. Farther increase in the area of the fins will cause the slightly displaced model to move back to its original position with its axis along the air current.

The effects are unaltered if the model, instead of being placed in an air current, moves in still air with a forward motion along its axis of symmetry. The bare model is unstable when in motion in the direction of its axis and always tends to alter its direction; the defect is diminished by adding vertical tail fins, for a certain area the model will remain moving parallel to its slightly displaced direction and is in neutral equilibrium, whilst for larger fin areas it will be in stable equilibrium and will maintain a straight motion in the direction of its axis. This behaviour in the several circumstances is analogous to the unstable, neutral, and stable equilibrium of ships when slightly heeled; but, unfortunately, there is no easily determined point corresponding to the transverse metacentre, the position of which relatively to the centre of gravity can be used to determine the nature of the equilibrium when in motion, *i.e.*, whether stable, neutral, or unstable.

The apparatus of the aerodynamical laboratory can measure the direction and amount of the whole pressure on an airship model and also its moment about the centre of gravity, and from these measurements the position or line of action of the whole pressure at any angle can be determined. For the bare model this line of action is always before the centre of gravity—G in Fig. 1—except for two positions of the axis of the model, viz., when it is parallel to the current and when lying across it in the final position of rest. For all other angles it tends to turn the model towards the latter position. When lying along the current the model is unstable and the slightest angular displacement will cause it to move further away. Paradoxical as it may appear, experiment shows that for small angles between the axis and the current the whole pressure acts at a very appreciable distance in front of the nose of the model, a result confirmed by mathematical analysis.

The addition of vertical fins to the tail of the model introduces another force when the axis is inclined. This force is the pressure on the fins and tends to rotate the model in the opposite direction to that in which the pressure on the bare model turns it. The total pressure on the model is the resultant of the two, *i.e.*, that on the bare model and that on the fins, and will act along a line nearer to the centre of gravity than the former pressure—B, Fig. 1.

As the area of the fins is increased the line of the total pressure gradually moves aft until a certain fin area is reached, for which it will pass through the centre of gravity, or, more accurately, through a vertical line passing through that point. When this happens the moments of the pressure on the fins and on the bare model, both taken about the centre of gravity, are equal and opposite, and there is nothing tending to rotate the model from its displaced position. It is in neutral equilibrium—C, Fig. 1.

Further increase in the fin area brings the line of the total pressure abaft the centre of gravity, the moment of the pressure on the fins is greater than that on the bare model, and the latter will turn from its displaced to its original position along the air current—D, Fig. 1.

The position of the point E where the line of the resultant pressure cuts the axis of symmetry relative to the centre of gravity G determines the nature of the equilibrium of the body when it is in motion. If E is before G, the motion is unstable; if E and G are coincindent, it is neutral; whilst if E is abaft G, it is stable. For small angles of displacement of the axis the point E is analogous to the transverse metacentre.

From the preceding remarks it is not difficult to see that if vertical fins are fitted at the bow the pressure on them when the model is inclined will increase the instability, and that to secure stability larger tail fins are necessary than if the bow fins were omitted. It is also apparent that a small fin area at a great distance is as effective as a larger fin area at a smaller distance from the centre of gravity.

The airship model has been supposed turned about a vertical axis, and to secure stability in motion vertical fins have been shown to be necessary. If turned about a horizontal axis, as when an airship changes altitude, it can be shown that horizontal tail fins must be fitted to obtain stability. For rotation about any other axis both sets of fins are effective in securing the same object. A submarine navigating well below the surface is similar, so far as stability of motion is concerned, to an airship and, like the latter, is fitted with both vertical and horizontal tail fins or their equivalents.

The longitudinal stability of an ordinary surface ship is considerably greater than that of an airship or a submerged submarine, and is sufficient provision against changes of motion about a transverse axis. Horizontal fins are neither required nor fitted. Rotation about a vertical axis is, however, possible and likely, and is necessary when the vessel is steered, and to secure stability of motion vertical fins or their equivalents are arranged for. The after deadwood, with its vertical sides and relatively large distance from the centre of gravity, is the feature corresponding to the vertical tail fins of an airship, and to it must be added the rudder itself, which, when no helm is given it, assists in securing stability. Unlike the airship, in which the transverse vertical sections are circles, the surface ship has a large extent of immersed vertically disposed surfaces, which, when the vessel is inclined to the direction of motion, are subjected to horizontal transverse pressures tending to turn her. If such surfaces are at some distance from the centre of gravity they have an appreciable effect on the nature of the equilibrium when the ship is in motion ahead. Such surfaces, for instance, are those at the bow of a fine-lined vessel, whose sides below water and for some distance from the stem are nearly vertical and but slightly inclined to the plane of symmetry. These surfaces act as vertical bow fins and tend to produce instability when the ship is in motion. In many submarines the horizontal tail fins are altogether or in great part replaced by the adoption of a wedge-shaped stern, the thin edge of the wedge being horizontal and at the extreme after end, the transverse vertical sections gradually changing from a very flat oval form aft to a nearly circular one towards amidships. The horizontal top and bottom surfaces of the after sections of such a vessel behave as horizontal fins and give stability.

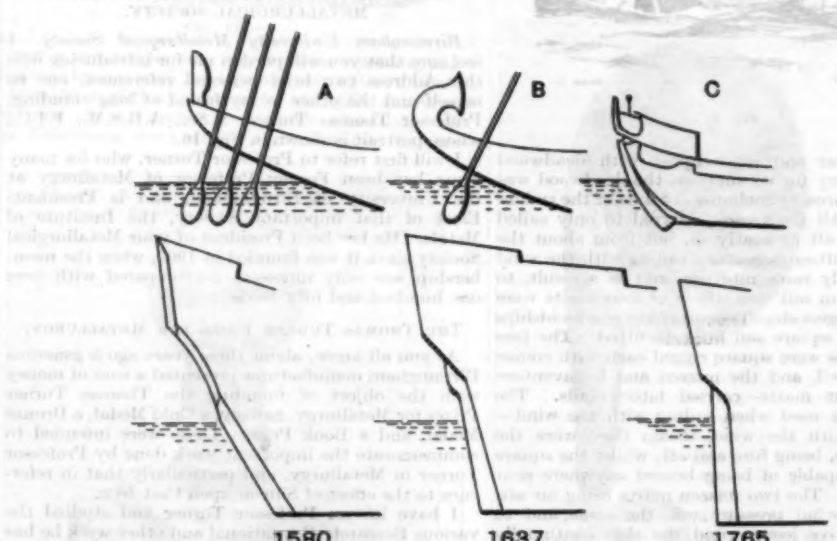


FIG. 2

A ship which is unstable about a vertical axis when in motion requires a continual use of the helm, since every unsymmetrical force operating will throw her off her course, and her instability will exaggerate the deviation. The helm has to be used to bring her back to the original course, and used very judiciously to

prevent swinging across in the other direction. The greater the instability the more frequently the helm must be used. A ship in neutral equilibrium will be deviated from her course by accidental forces tending to turn her, but when these cease she retains the new course and does not tend to move away from it. The helm must be used to regain the original course, but will not be required so frequently or applied so carefully as in an unstable ship. With a ship which is stable in motion a straight course can be kept with little or no use of the helm.

If her course has to be altered, a ship which is stable in motion will, other things being equal, require more helm to effect a given alteration in her course in a definite space and time than an unstable one. The latter, by reason of her instability, assists the rudder in altering course, whilst the stable vessel resists it.

The fitting of tail fins to stabilise the motion of an elongated body has been a practice for many centuries, although the reason for the beneficial result which is obtained was not understood until comparatvely recently. The maker of arrows, or fletcher, as the craftsman was termed, fitted fins of goose or other birds' feathers to the tail of the arrow shaft to ensure a straight end-on flight after the arrow had left the bowstring. Probably this is the oldest application. The tail of the weathercock is another nearly as old.

The after deadwood in ships was a much later application. Egyptian vessels, 3000 B.C., had hulls of flat crescent shape in profile, transverse sections of circular segments, but no keel or deadwood. The purpose of the latter was served by three—sometimes six—broad-bladed steering oars used right aft—A, Fig. 2—and immersed edge on to the water when the vessel was sailing. Fifteen hundred years later the three had been replaced by one stouter and broader bladed—see B, Fig. 2. Later, the Mediterranean galleys, whose favourite tactics when in action was to ram the enemy, had to be capable of easy and quick turning with a steering oar, and for this reason were well rounded at the forefoot and stern. Even when in the thirteenth century the middle line rudder replaced

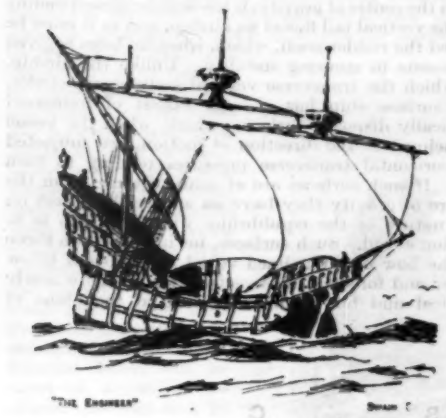


FIG. 3

the steering oar and a sternpost with deadwood became necessary for its support, the deadwood was made of small area by inclining the axis of the rudder—C, Fig. 2. All the vessels referred to only sailed with the wind aft or nearly so, but from about the middle of the fifteenth century sailing with the wind abeam gradually came into use, and as a result, to secure maximum sail area, three or four masts were fitted in the largest ships instead of the one amidships with yard and square sail hitherto fitted. The fore and main masts were square rigged each with course and later topsail, and the mizzen and bonaventure mizzen—if four masts—carried lateen sails. The latter were not used when sailing with the wind—Fig. 3—but with the wind abeam they were the important sails, being fore and aft, whilst the square sails were incapable of being braced anywhere near that direction. The two mizzen masts being far aft, the resultant wind pressure was the same, and to prevent excessive leeway, and the ship continually going up into the wind, deadwoods became necessary. The towering poop erections holding a considerable amount of wind emphasised the necessity. As experience was gained the deadwoods gradually increased in size—see Fig. 2.

If the position of the point E of Fig. 1 could be calculated the nature of the equilibrium of a ship when in motion could be determined in the design stage, but unfortunately this cannot be done, and it is only at the ship's trials that a knowledge of her behaviour can be obtained. Such information is, however, useful for future designs. In the sailing warship the point E was taken as at the centre of area of the immersed middle line plane, and was termed the centre of lateral resistance. The point of application of the wind pressure—the centre of effort—was likewise assumed to be at the centre of the sail area, the sails being braced fore and aft. The distance measured longitudinally between the two points was made the same proportion of the ship's length as in successful vessels, the centre of effort being taken *forward* of the other point. This method was a very rough approximation, for in order to obtain the best result—that is, ardency, or the vessel tending to come into the eye of the wind—the actual centre of effort should be slightly *aft* of that of lateral resistance. If on trial the results were unsatisfactory the defect was not difficult to remedy, for either the ballast could be shifted and the trim altered, thus modifying the position of the centre of lateral resistance, or the sails modified in area or position, thus altering the centre of effort.

It is now known that when a body is slightly inclined to the direction of motion as in Fig. 1 or as in a sailing ship with leeway, the pressure on the forward portions per unit area is much greater than on the after parts. For the sailing ship this caused the centre of lateral resistance to be well forward of its assumed position, and also before the centre of effort. The latter for the same reason was forward of its assumed position, but not to such an extent as the other, since the pressure on each sail attained a maximum at the fore edge and the effect was more distributed over the whole. In the very bluff bows then adopted the greater pressures over the forward parts, due to inclination of the ship, were inclined to the middle line plane, and the transverse components were less than for the finer-shaped bows of modern steamships. In these the greater pressures on the forward portions form the main factor determining the nature of the equilibrium when in motion, and the cutting away of the forefoot improves the stability and at the same time removes useless weight and secures a finer entrance. The pressure per unit area on the after deadwood is smaller than the pressure forward, more especially when the deadwood is a continuation of the main body of the ship; but it may be considerably increased by making it discontinuous with the latter, and so giving it an independent pressure system which will cause the pressure on it to be greater than when continuous with the main hull. It is for this reason and for others referred to later that the shape chosen for the deadwood in model yachts and submarines, and to a smaller extent in larger warships, is adopted. The effect of the greater pressures on the bows can be diminished and the stability improved by increasing the trim of the ship by the stern. The point E of Fig. 1 shifts aft by decreasing the area forward subject to the greater pressures. The foregoing remarks apply to small deviations of a ship's course. In a succeeding article it is proposed to consider larger departures, as when a vessel turns under helm.

The History and Progress of Metallurgical Science.*

By SIR ROBERT HADFIELD.

SECTION IV.—THE BIRMINGHAM UNIVERSITY METALLURGICAL SOCIETY.

Birmingham University Metallurgical Society.—I feel sure that you will pardon me for introducing into this Address two brief personal references, one to myself and the other to my friend of long standing, Professor Thomas Turner, M.Sc., A.R.S.M., F.I.C., whose portrait is shown in Fig. 16.

I will first refer to Professor Turner, who for many years has been Feeney Professor of Metallurgy at the University of Birmingham, and is President-Elect of that important Society, the Institute of Metals. He has been President of your Metallurgical Society since it was founded in 1905, when the membership was only nineteen, as compared with over one hundred and fifty to-day.

THE THOMAS TURNER PRIZE FOR METALLURGY.

As you all know, about three years ago a generous Birmingham manufacturer presented a sum of money with the object of founding the Thomas Turner Prizes for Metallurgy, namely, a Gold Medal, a Bronze Medal, and a Book Prize. These were intended to commemorate the important work done by Professor Turner in Metallurgy, and particularly that in reference to the effect of Silicon upon Cast Iron.

I have known Professor Turner and studied the various Research, Educational and other work he has carried on for some thirty-five years with results so highly appreciated by all of us for their great merit and worth. A more true and faithful worker in the cause of Metallurgy does not exist. Professor Turner was elected a Member of the Iron and Steel Institute in 1887, before which Society he read papers on "Alloys of Iron and Silicon" in 1889, and "Aluminium Steel" in 1890. His book on *The Metallurgy of Iron* was written in 1895. He also carried out most useful research work on hardness determinations and contributed valuable papers on this subject when introducing his Sclerometer, which had a diamond point with a weight and a graduated lever, and on it a scale of about one hundred divisions. This fulfilled the purpose at the time for the particular object its designer had in view.

Professor Turner was occupied in his researches as to the effect of Silicon upon Cast Iron just about the same time that I was engaged in working out my invention of Manganese Steel. I am glad to think that both those investigations were carried out with but one thought in mind, that is, to increase general knowledge, and I trust that the results obtained have shown that this aim has been achieved.

Whilst speaking of the work of Professor Turner, it is interesting to recall that amongst those who have been Students and worked under him in the Metallurgical Department of the old Mason College were our Prime Minister, the Right Hon. Stanley Baldwin, also the Right Hon. Neville Chamberlain. Mr. Baldwin was interested in his father's business near Stourport, and the fact just mentioned shows how desirous he was to equip and qualify himself as a Scientific Metallurgist. As regards Mr. Neville Chamberlain, he was for some time connected with the well-known Birmingham firm, Elliott's Metal Company, at Selly Oak, and other metallurgical enterprises.

Two other well-known men have been students of metallurgy under Professor Turner, one being Sir Henry Fowler, K.B.E., whose knowledge and skill were of such great service to the Nation during the War. I can truthfully say that the National Factory my firm then erected, representing an expenditure of some three-quarters of a million pounds, would not have been completed at such an early date—that is, in only ten months—but for Sir Henry's help. His untiring energy at the present time on behalf of Engineering and the education of the Engineer are greatly to be admired. His Address as President of Section G, Engineering, at the recent Meeting of the British Association in Liverpool, on "Transport and its Indebtedness to Science," is not only interesting, but a most valuable contribution and ought to be read by all those concerned. The second student referred to and well known to most of us was Professor McWilliam, who has, alas, passed away. He served for two years under Professor Turner, and was County

FIG. 16—PROFESSOR THOMAS TURNER

Lecturer in Metallurgy at Stafford before he came to Sheffield to work under Professor Arnold.

Turning now to the second personal reference, which concerns myself, to my surprise on June 20th last I received from Mr. J. H. Costain, your Registrar, the gratifying intimation that the first award of the Thomas Turner Gold Medal had unanimously been made to me as a mark of appreciation of the work I had done in Metallurgy. To be the first to receive this distinction is indeed a great honour, still more that this award should be associated with the name of my friend, Professor Turner, with whom I have had uninterrupted friendship for something like twenty-five years, and from whose work on behalf of Metallurgy I have greatly profited. In both public and private discussions I cannot remember an unkind or unpleasant word having passed between Professor Turner and myself, even during the most strenuous arguments. Long may his success continue in the important post he occupies. We all owe him a deep debt of gratitude for his painstaking and accurate work on behalf of the branch of Science known as Metallurgy. I also offer best wishes for the future success in his career to Professor Turner's son, Mr. T. Henry Turner, M.Sc., who is worthily following in his father's footsteps.

Speaking further with regard to the constitution and working of the Birmingham University Metallurgical Society, may I add that the Chairman, who is elected annually, is at present Mr. W. K. McMillan, and the Secretary, Mr. D. W. Clarry, to whom I express my best thanks for the useful information he has been kind enough to furnish regarding the Society and its work. The Society is also greatly indebted to Mr. May, now President of the Guild of Undergraduates, and to Mr. Wharton, last year's Chairman and Secretary, for the large amount of work they have done on its behalf, particularly in arranging the first Inter-University Metallurgical Conference. It is to be

* An address delivered before the Birmingham University Metallurgical Society on Tuesday, October 30th, 1923. Abridged.

Continued from page 537.

noted with interest that Delegates of the Society went to Germany in the Easter vacation, and that about twenty-five members spent three weeks in that country, visiting Hamburg, Hanover, Brunswick, Berlin, and Upper Silesia.

TECHNICAL SOCIETIES, RESEARCH AND TRADE ASSOCIATIONS IN BIRMINGHAM.

Staffordshire Iron and Steel Institute.—As regards local technical associations, I would refer to the excellent work carried out by the Staffordshire Iron and Steel Institute, which was founded in 1866. Amongst its past Presidents are Mr. William Lester, who first filled the Chair, Professor Turner, and the late Professor H. le Neve Foster. Its present President is Mr. F. J. Cook, who by this position also occupies a place of honour as Member of Council of the Iron and Steel Institute.

Association of Drop Forgers.—There is also the important Association of Drop Forgers and Stampers in Birmingham, where this business is conducted on a large scale.

British Cast Iron Research Association.—We all regret the retirement on account of ill-health of Dr. Percy Longmuir from the Directorship of the British Cast Iron Research Association, and we trust that his ill-health is only a temporary matter. Mr. Thomas Vickers is the present Secretary.

British Non-ferrous Metals Research Association.—Dr. R. S. Hutton, who has had an exceptionally varied experience in scientific research and industry, is the Director and Secretary of the British Non-ferrous Metals Research Association, which has its central office in Birmingham. The Birmingham University has throughout been closely connected with the work of the Association, and has had its researches carried out in the Metallurgical Department under the supervision of Professor Turner. The recent progress in the support of the Association by firms in Birmingham and elsewhere is remarkable, and the programme of its researches includes several subjects which under the special circumstances attending this branch of industry could scarcely be attacked otherwise than by such co-operative effort.

Birmingham Metallurgical Society.—Another important organisation is the Birmingham Metallurgical Society, founded in 1903, and incorporated in 1920, whose President for this Session is Mr. Harold W. Jacks, and the Secretary Mr. A. C. Craig. Its membership during the War was close upon 1000 and is now about 600. Amongst the past Presidents have been Professor T. Turner, who has occupied the Chair in seven different years, Mr. Lantsberry, and the late Mr. A. H. Hiorns, who had much to do with the founding of the Society and whose efforts on behalf of science were much appreciated. The work of the Society covers both Ferrous and Non-ferrous Metallurgy, as also other subjects of a kindred nature. A Prize of five guineas and a Bronze Medal is offered every year for a thesis of Metallurgical interest by a student of the technical schools in the Midlands. Papers of considerable merit have been submitted in connection with this scheme.

The Iron and Steel Institute.—When speaking of technical societies devoted to Metallurgy, it may well be said that Birmingham has fully performed its share of educational work in this direction. Our leading technical body, as regards those interested in Metallurgy, is the Iron and Steel Institute, founded in 1870, with the Duke of Devonshire as its first President, and afterwards followed by a long and illustrious line of Presidents, including one American, one Frenchman, and one Belgian, for we are a cosmopolitan body. This Institute is represented in the Birmingham District by 51 Members, Staffordshire has 55, and Shropshire and Warwickshire 33 Members; that is, a grand total of 139 for the district. Mr. G. Hatton, C.B.E., Brierley Hill, Staffordshire, is a Member of Council of the Institute, as well as Mr. F. J. Cook, President of the Staffordshire Iron and Steel Institute, both of whom, by their help and encouragement, have rendered great service to Metallurgy.

The Iron and Steel Institute has never yet had a Birmingham born man as President, although Dr. Percy, who lived so long in your city, occupied the Chair in 1895. I hope, however, that this may occur before long, as your city is more than entitled to the honour. Mr. Arthur Keen, so well known to most of us, was for many years a Member of Council of the Institute, and had he lived would undoubtedly have filled this position. At the Iron and Steel Institute Meeting in Birmingham, 1895, with Sir David Dale as President, Sir Benjamin Hingley, Bart., the Chairman of the Reception Committee, described your city as being "the great centre, the metropolis of the iron industry and of metalliferous work in England." Mr. Arthur Keen was Treasurer of the Local Reception Committee. One of the papers then read was on "The Iron Industry of South Staffordshire," by Mr. Daniel Jones, F.G.S., Secretary of the South Staffordshire Ironmasters' Association, who gave the graphic description, already quoted, of the appearance of this district about the middle of last century, when furnace gases were allowed to burn wastefully in the open air. At this same meeting I read a paper on "The Production of Iron by a New Process." I obtained direct from the oxide an iron containing only .03 per cent. C. Although this related to comparatively small laboratory experiments, there were then outlined methods of producing pure metals which have since been adopted on a commercial scale.

Associateship of the Iron and Steel Institute.—There is one point I wish specially to mention this evening, and that is, each member of this Society should sooner or later join one of the great Technical Institutions, whether Civil, Mechanical, Electrical, or Metallurgical. The Iron and Steel Institute offers special attraction to those interested in the study of ferrous Metallurgy. An interesting feature of the policy adopted by the Iron and Steel Institute in 1916 is that it was decided to accept candidates for election as Associates. Persons not exceeding twenty-four years of age are therefore eligible if they possess the following qualifications: students of Metallurgy taking courses at a University college or technical school; pupils who are apprentices of metallurgists or engineers, or in metallurgical or engineering works; and persons employed in some practical or scientific capacity in metallurgical or engineering works. The subscription is exceedingly moderate—only one guinea per annum and no entrance fees—a less sum than most of even the small engineering societies charge for membership. This Associateship enables individuals interested in Metallurgy to obtain at once the whole benefits of the Institute with the exception of voting; that is, an Associate has the right to attend all meetings and receive all notices and publications.

Federation of British Industries.—It may be interesting to add that Birmingham was practically the birthplace of the Federation of British Industries and provided its first President, Mr. F. Dudley Docker, C.B., who has done so much for the city's manufacturing interests. The present President, the Right Hon. Sir Eric Geddes, G.C.B., G.B.E., is also now intimately associated with one of the large Companies in Birmingham. The Membership of the Federation consists of 1889 Associations, manufacturing concerns, and others, of which about one-sixth belong to Birmingham. Its powerful voice is felt even in Government circles and Parliament. Despite the heavy and long-continuing trade depression, recruiting of new members steadily proceeds. The Birmingham office of the Federation covers the five counties of Warwickshire, Staffordshire, Shropshire, Worcestershire, and Herefordshire. At present the local organisation is controlled by a representative and influential Area Committee under the Chairmanship of Sir David Brooks, G.B.E., who was Lord Mayor of the city during the years 1917 to 1918 and 1918 to 1919. Authority has been obtained and when conditions are more settled district committees will be set up in Wolverhampton and the Black Country, Coventry, Kidderminster, and the Pottery district.

To be continued.)

The Wireless Exhibition.

No. III.*

NOT a few people who buy wireless receiving sets designed for use with headphones very soon cultivate a desire to employ a loud speaker, and then, of course, the use of an amplifier becomes essential. At the Exhibition were shown a considerable number

FIG. 26—B.T.H. AMPLIFIER

of single and two-stage amplifiers suitable for attaching to existing receiving sets. One of the neatest and cheapest amplifiers which was brought to our notice was the single-valve unit shown in Fig. 26, which is one of the British Thomson-Houston Company's wireless products. This amplifier consists of a pedestal composed of a moulded insulating compound. On the top of this pedestal is a valve holder, whilst inside the pedestal there is a low-frequency transformer of special design. The terminals are reversible, and it is possible, when two stages of amplification are necessary, to plug two of these units together. A good degree of low-frequency amplification can, therefore, easily be obtained, for two or more of these amplifying units can be coupled together with perfect ease. A two-valve power amplifier is also made by the British Thomson-Houston Company, and it is shown in Fig. 27. This amplifier has been designed for use with loud speakers which will give a large volume of sound. The working parts are enclosed in a box composed of four insulating composition panels, which stand on a polished

FIG. 27—B.T.H. POWER AMPLIFIER

walnut base, and at the top of the case there is a cover composed of the same material. Incidentally, the makers of these amplifiers are very proud of this special insulating material, and claim that it is preferable to ebonite. On this power amplifier the company's B4 valves are used. The valves are placed inside the case, but they can be seen through windows provided in the cover. These valves only consume .25 ampère at 6 volts, and the energy consumption is, therefore, about one-sixth of that usually required by other makes of power valves. The anode potential recommended is 100 volts. Two switches are fitted to these amplifiers. One switches the current on and off, and the other controls the volume of the sound to suit requirements.

The British Thomson-Houston Company's loud speakers are made in various forms. In the construction of these instruments moulded insulation is used, and the magnets are composed of cobalt magnet steel. Each instrument is provided with an adjustable air gap, so that the best results may be obtained under different conditions. Standard instruments

FIG. 28—B.T.H. LOUD SPEAKER

are wound for 2000 ohms, but other windings can be provided if required.

One of the same company's standard loud speakers is illustrated in Fig. 28, and another instrument, designed to give a large volume of sound and for use in conjunction with a two-valve power amplifier, is shown in Fig. 29. This instrument, which works on the electro-dynamic principle, is provided with a number of cobalt steel magnets, which provide the requisite field without the use of a battery. The output terminals of the amplifier are connected to the primary winding of a telephone transformer, which is housed within the base of the instrument,

* No. II. appeared November 16th.

and upon the base the magnetic system is mounted. The secondary winding of the transformer is connected to a moving coil which floats freely in the magnetic field. Any variation of the current in the coil causes movement of the coil, and this movement is transmitted to a diaphragm which is attached

FIG. 29—ELECTRO-DYNAMIC LOUD SPEAKER

to the coil. The device shown in Fig. 30 is a gramophone attachment, which enables an ordinary gramophone to be used as a loud speaker.

One of the most novel and interesting loud speaker exhibits was the "Crystavox," shown by S. G. Brown and Co., Limited, of Victoria-road, North Acton. This instrument, which is shown in Fig. 31, has been designed for use with a crystal set and without the employment of valves. Any receiving set which is used not more than 10 miles from a broadcasting station, and which is capable of giving good audible signals in headphones, will, it is claimed, operate the "Crystavox," and a good volume of clear and undistorted sound, which can be heard all over an averaged sized room, is produced. At first sight, this may seem impossible, but there is no doubt whatever that the "Crystavox" works. The secret of its operation lies in the fact that in the base of the instrument is a sensitive Brown microphone amplifier, which picks up the small fluctuating currents

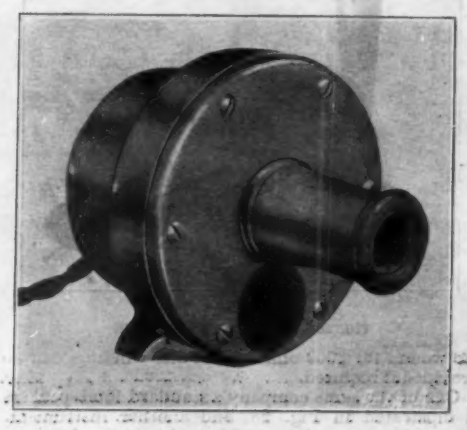


FIG. 30—GRAMOPHONE ATTACHMENT

from the receiving set and amplifies them sufficiently to make them work the loud speaker. It is well known that the current required to work the Brown microphone amplifier is very small. For working the amplifier associated with the "Crystavox," a a small 6-volt dry battery is employed, and even if the loud speaker is in constant use the battery will last for months. Beyond the cost of a new battery when the original battery has given out, there are no other working expenses. To put the "Crystavox" in operation, all that is necessary is to couple up the telephone terminals of the receiving set to the loud speaker and to connect two other terminals to the dry battery. The receiver is tuned in the ordinary way. For final adjustment of quality and loudness of tone, a magnetic device is provided in the base of the "Crystavox."

The Edison Swan Electric Company, of 123, Victoria-street, was showing a number of complete crystal and valve sets and component parts. Of the valve sets the company's so-called "Toovee" two-valve receiver was perhaps the most interesting.

FIG. 31—CRYSTAVOX LOUD SPEAKER

In this set an improved method of dual amplification, with reaction, is used. It is claimed that the instrument will receive the transmissions of any of the British broadcasting stations, and will work a loud speaker 30 or 40 miles from a broadcasting station. The set is of the vertical panel type, and the valves are mounted inside the case. Another set exhibited had four valves. This is a long range set with several special features, such as a change-over switch for the purpose of changing from headphones to the loud speaker. Two of the component parts exhibited by the company are shown in Fig. 32, one being a very well made variable condenser, and the other a high-frequency transformer of the plug-in type. Low-frequency transformers made by this firm have a ratio of 1 to 3.5, and a .001 microfarad condenser

FIG. 32—CONDENSER AND TRANSFORMER

is connected across the primary. There was also a comprehensive range of the well-known Ediswan transmitting and receiving valves.

The exhibits of L. McMichael, Limited, of Hastings House, Norfolk-street, Strand, consisted of experimental receiving sets and units, and sets designed for people who only require to listen in. There were also many component parts and accessories. Two very fine four-valve receiving sets were shown. In each case there is one high-frequency valve, a detector and two note-magnifying valves, and with the aid of key switches either of the two latter valves can be put out of action, so that two, three or four valves can be used at will. Signals that are audible in the telephones and are magnified by the last two valves to an extent sufficient to work a large loud speaker. Within reasonable distance of a broadcasting station, say, 50 to 75 miles, according to aerial height and situation, the volume of the music reproduced is sufficient for dance purposes. In the case of one of these sets a high-frequency transformer is used, whilst in the other case the high-frequency coupling consists of a tuned anode coil. The set with the latter form of coupling also has a separate tuner. Both these sets are very well made, and we should imagine that they are also very efficient. The set with the tuned anode coupling has a multi-contact switch, with the aid of which the anode coil is adjusted to suit different wave lengths from 300 m. upwards.

Marconi's Wireless Telegraph Company, Limited, was exhibiting some new and very elaborate sets, enclosed in very handsome cases, including a set composed of six high-frequency valves and one detector. A very neat combination was made up on a table, designed to take the batteries underneath. The equipment was composed of an ordianry Marconiphone, a separate two-stage amplifier, and an Amplion loud speaker. This outfit is sold complete, or, of course, the parts are supplied separately. The valves in the Marconiphone set, shown at the Exhibition, were of the company's latest dull emitter type, the current consumption being .06 ampère at 3 volts. In the amplifier, however, one ordinary R valve and an L S_5 valve are generally used. A new Marconi dull emitter power valve has recently been introduced. The valve has a low impedance, and is capable of dealing with a large amount of energy without producing distortion.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

ONE-WIRE AND THREE-WIRE SYSTEMS FOR RAILWAYS.

SIR,—The article on the above-named subject on page 426 of your issue of October 19th last is singularly inaccurate. No doubt the statements it contained did come as a surprise to most people. I do not propose to deal with the statements in the article re Post Office wires on railways, which are misleading, but, to come more particularly to the object of this letter, to deal with block instruments and wires.

As the article states, the wires and instruments are subject to damage by lightning, but there is, in addition, a very great danger of lightning causing wrong and false clear indications on the block instruments used in the so-called one-wire block system, which is more dangerous owing to the subtle action of the lightning on the single-wire instruments, on the indications of which the safety of the traffic depends.

There are on many telegraph pole routes from fifty to a hundred wires. Even granting that two wires of the three wires used in three-wire block system could be dispensed with, the effects of the storm on the remaining wires on the route would not materially be altered. The cost of installation, maintenance and renewal of the one-wire system depends—as with every other system—upon the cost of the one-wire instrument, which is very high and the cost of the necessary wire, which at the present time is much lower than £20 quoted by you.

The name "one-wire" system is a misnomer, as one wire and earth return has had hitherto to be used. It can be shown that this is dangerous, insomuch that wrong indications and false clear signals are possible, when so installed in country districts, but in electrified areas and many miles surrounding it would be out of the question to use earth return alone with the one-wire block instruments; therefore a return wire must be run, which at once converts the one-wire into a two-wire system. The same to a lesser degree could be said of the three-wire block and a return wire put up, making it a four-wire system, the proportion of gain in wires being as two to four instead of one to three; but the high cost of the instruments has to be considered.

The article overlooks the fact that there have been several "one" wire block instruments in use for many years—Harper's, Preece's, Walker's, &c.—but in many cases the "lock" feature of (Syx) lock-and-block system has been added to ensure safety, and in many instances the one-wire instrument has been replaced by three-wire systems on account of the greater liability to faults of the one-wire system.

The difference between the two systems is that the three-wire system is a continuous positive system and the indications are positively given by a continuous current, the absence of which, in case of the wire breaking, causes the indicator to go to the "danger" position in both signal-boxes; but in the case of the one-wire system the indications are given by a current of short duration, and the indicators, on the bell being rung, go to either the "clear" or "danger" position and remain in that position until it is required to give a different indication, when the commutator is rotated and the bell rung, when the indicators change accordingly and remain in that position as before. Now, after the current has ceased, suppose the indicators in both signal-boxes are showing "line clear" and the wire breaks, the indicators at each signal-box still show "line clear." If the signalman at one of the signal-boxes now rotates his commutator and rings the bell code to block the line to the other signal-box, the indicator at the latter box remains in the "line clear" position, so that you have a false clear signal on the instrument.

The article is unfortunate in referring to the London, Brighton and South Coast Railway, as is well known, on their busy sections Syx three-wire lock and block has been in use very many years.

The electric tablet or train staff system for single lines cannot fairly be compared with the block system on a double line.

The cases where the one wire of the one-wire block system is down alone are much more numerous than the cases where a large number of wires are down at the same time through storms, and it is so, that, in addition to the wrong indications that are exhibited in the signal-boxes, the block working over the block instruments is entirely suspended until the wire has been repaired.

The estimated saving of £50,000 if the three bigger groups were to adopt the one-wire block system is a flight of fancy.

There are 17,749 route miles of railway on the three largest groups, a large portion of them single line; but supposing the three-wire system existed all over the three groups of railways and two wires could be recovered over the whole length of lines, then the decreased maintenance claimed in your article would be at 25s. per mile of wire on 35,498 miles of wire, a total decrease in maintenance of £44,375, which is far below the £50,000 given in the article. The two wires could not be recovered over the whole line, owing to the necessity for return wires to avoid stray currents. Against this saving would have to be set the cost of removing the three wire instruments and replacing them by one-wire instruments. There are 11,016 signal-boxes in the United Kingdom. One pair of instruments, with bells in each signal-box, of the one-wire three-indication type to which the article obviously refers, but does not mention specifically, would cost, at present prices, £517,752. The annual interest on this at 5 per cent. would be £25,887, and the maintenance and renewal £41,419 per annum.

Certainly all the block instruments recovered would be valueless; similarly, the recovered wire would be mostly scrap. The cost of labour and technical skill for installing would not be small, so it is evident that instead of £50,000 saving, the additional costs in the way of interest, maintenance and renewal would be very great and prohibitive.

The disadvantages of the one-wire system admitted in the concluding remarks of the article are quite sufficient to show its liability to dangerous failures, and when, in addition, as I have shown, the increased cost of the change would be so immense, it is evident that the three-wire three-indication block system is in every way preferable.

SIGNAL AND TELEGRAPH SUPERINTENDENT.

November 17th.

[Metallic returns are only used where the wires run through areas that have electric traction on the railway or on tramways near. The "line clear" indication would not be used for a second train until "train entering section" had been "belled" for the first and the indicator had been changed to "train on line." These signals could not be given were the wire down. The greater portion of the "Brighton" line has one-wire instruments, and since our article appeared we learn that we should have included the Great Eastern, Caledonian, and Taff Vale as users of the one-wire system—very significant additions. We have again gone through our figures and see no reason to modify our estimate except to say that it represents an ultimate saving, of course, and not an immediate one.—ED. THE E.]

THE GEARED DRIVE.

SIR,—In connection with a leading article entitled "The Geared Drive," which appeared in your issue of September 14th, 1923, we would make the following remarks:—

You state, "If, however, that gear [McAlpine floating frame drive] is consistently successful, other things being equal, then we ought to admit at once that we have made an error in adhering so long to the rigid drive and reform our practice. Indeed, the whole subject is one on which greater flexibility of thought and more daring in experiment is needed."

We would point out that over two years ago we decided to adopt the floating frame gear as our standard practice, and made arrangements with the Metropolitan-Vickers Electrical Company, Limited, Manchester, the licensees of the McAlpine floating frame gear in this country, to build it. Since that date we have completed five vessels, one of which is a twin-screw job, and all of which are now in operation and giving complete satisfaction. The total power represented in those five vessels is 21,800 shaft horse-power.

We, in conjunction with our friends, the Metropolitan-Vickers, had for some time previous to the adoption of the floating frame type of gear, been of the opinion that "to make a casing that will not distort in some degree under the influence of the ship in a sea-way is impossible." This subject has indeed been under the closest consideration for many years. The Metropolitan-Vickers early adopted a special type of gear-box seating, which was so designed that twisting of the ship was not transmitted to the gear-box. Subsequently the same company produced a design which allowed of flexibility between the wheel and pinions in much the same way as is achieved by the McAlpine floating frame. It was at length, however, decided that inasmuch as the McAlpine arrangement had been tried out, with complete satisfaction, in numerous vessels built in America, it was preferable to adopt this arrangement than to construct another which, while having the same object in view, introduced certain untried novelties.

This type of gear, which is now adopted as our standard practice, involves other important features in addition to the floating frame. Each high-speed pinion is driven by means of a quill shaft. This shaft, which passes through the pinion, is keyed to it at the end remote from the turbine; at the other end the quill shaft is connected to the turbine by means of a flexible coupling, which allows axial movement. The introduction of the quill shaft was decided upon in order to enable slight variations in angular velocity of the pinion—due to unavoidable inaccuracies in gear cutting—to take place without imposing the same change of velocity on the turbines. This is produced by the slight torsional yield of the flexible quill shaft. If this quill shaft is not fitted any change in angular velocity of the pinion must be transmitted to the turbines, the kinetic energy of which is very large. It will, therefore, be seen that if the quill shaft is dispensed with there is bound to be a more or less severe hammering action between the high-speed pinion and first reduction wheel due to the impossibility of impressing small changes in angular velocity on the turbine. Quill shafts are also arranged for driving the second reduction pinions.

We early realised that for a double reduction gear to be thoroughly satisfactory it was important to eliminate as far as possible the interaction between the gears. For this reason the three gear-box arrangement was adopted and flexible couplings were introduced between the high-speed gear wheels and the second reduction pinions. This enables the second reduction pinions to float relatively to the main gear wheel and at the same time the high-speed pinions are able to float relatively to the first reduction wheel quite independently.

It is claimed that the arrangement described above has the following advantages:—

(1) By the introduction of the three gear-box arrangement and sliding couplings between both reductions, the double reduction arrangement is converted into the exact equivalent of two independent single reduction gears.

(2) The introduction of the quill shafts and the corresponding torsional elasticity reduces to a minimum the hammering effects, which are otherwise inevitable due to slight inaccuracies in gear cutting.

(3) The introduction of the floating frames enables the misalignment of gear wheels and pinions, which is bound to occur due to the yielding of the ship, to be rendered innocuous. Furthermore, if one of the pinion bearings should run, due to failure of the oil supply or any other cause, the consequent misalignment would result in very severe localised stresses with the ordinary type of gear. With the floating frame gear all that happens is that the floating frame tilts slightly on the flexible "I" beam, which is provided for the purpose, thereby correcting the misalignment.

We think you will agree that the above brief sketch shows definitely that the so-called "British point of view" with regard to the design of marine reduction gears, is not universally held in this country. In addition to the vessels referred to above, four other vessels, aggregating 12,800 shaft horse-power, have been fitted during the last two years with double reduction gears of the floating frame type, manufactured complete by the Metropolitan-Vickers Electrical Company.

SWAN, HUNTER AND WIGHAM RICHARDSON, LIMITED,
G. F. TWEEDY,
Director.

Newcastle-on-Tyne, November 20th.

THE PIECEWORK SYSTEM.

SIR,—I should be obliged if you could allow me space to make a few comments arising out of Mr. Taylor's letter on "The Piecework System" in your issue of November 2nd. Whatever he set out to prove, he has gone no further than to draw attention to the evils which may arise from bad application of piecework principles. His closing statement that "there is no redeeming feature in the system" is at variance with his preceding remark that "it really means ten men doing fifteen men's work." Surely such a reduction of cost is in the interests of the industry in general, provided the ten men are satisfied to make the additional effort; a cheaper product means a lower selling price, hence larger sales and more employment. Or, to take another view, are the fifteen men referred to working honestly in making their presence necessary on a job which it is possible for ten men to do? At all events, experience shows that the workers are willing to make this extra effort if given an opportunity of earning more than their usual rate. The fact of the operators being paid according to their output stimulates their interest in the work and makes them directly concerned in the time taken to carry out the operation.

It is essential, however, if the worker is to give his maximum output that the employer should have his confidence and goodwill. This is to a certain extent ensured by the agreement now in force referred to in your leader of September 14th.

The three clauses provide that:—(1) Daywork rates are guaranteed; (2) prices shall be such as to enable an average worker to make 33⅓ per cent. bonus; (3) prices shall be fixed by agreement. It follows as a corollary to (3) that prices cannot be reduced without the operator's consent. Thus the first clause guarantees that the worker loses nothing financially, and the third gives him power to reject an unfair price, *i.e.*, one which does not conform with the standard fixed by clause No. 2, and when once the price is agreed upon it cannot be altered. This is the most important point of the whole agreement, for when so protected the worker has lost his chief reason for wishing to conceal the possible output and is encouraged to make as much bonus as he can, whereas without this protection output is limited to that which will bring in a bonus which is not conspicuously large.

As regards the fixing of the price, as your correspondent "Superintendent of Production" implies, under the old system a price very often represented the minimum the foreman could get the operator to work to, not, as should be the case, a fair payment for the amount of labour required. He cites the case of machining, where prices can be logically deduced from existing data. Similar methods can be employed to work for which there is no standard data by making use of time study. Experience shows that though at first operators usually regard time study with suspicion, after a while they come to realise its justice when they find that they receive fair prices as a result of it, and often ask to have a job time studied as an appeal against a tight price.

It is hoped that working under the agreement mentioned and with prices logically deduced from reliable data, Mr. Taylor and his colleagues will find themselves able to obtain fair recompense for their exertions as pieceworkers. In conclusion, I might add that my experience is contrary to Mr. Taylor's, in that men usually grumble at having to perform work which is paid for at a time rate.

RATEFIXER.

Manchester, November 17th.

GOVERNMENT POLICY OF ELECTRICITY SUPPLY.

SIR,—Much is being written in the Press at present about the work the Electricity Commissioners are doing in the interest of lowering power generation costs by the division of the country into areas and the establishment of large central super-power stations in each of these areas. This policy is very welcome to manufacturers of large steam turbines and electrical plant, as it gives them practically the monopoly of future power developments in this country. Such plant is almost entirely manufactured by very powerful engineering companies, who also doubtless have considerable political influence.

The closing down of small power stations and their substitution by large central stations covering extensive areas means that heavy transmission losses are incurred which must be added to the cost of generation. Further, any failure of plant or cables would throw a very large area into darkness. The avoidance of high transmission costs can only be obtained by each community having its own generating station. Some super-power stations have shown economies, but transmission losses have not always been allowed for; similar gains would no doubt have been recorded by many of the smaller stations had they been allowed to modernise their plant. We are told the next war will take place in the air. What splendid key targets these super-stations will be for our enemies to locate and bomb, and thus paralyse large areas of the country with comparative ease. During the war this danger was forcibly demonstrated, and suggestions were made that the future safety of the country would be greatly increased if power stations were built underground.

There are many small power stations operating with Diesel engines quite as economically as the largest super turbine stations, yet these are faced with extinction by the present policy of the Electricity Commissioners, it being very difficult for such stations to get permission from the Commissioners to increase or improve their plant. Relief of unemployment is most important at present and would to a material degree be helped by the Commissioners granting to these small stations permission to extend, and thus relief would be immediate and not delayed over a long period; such extensions would help to reduce the cost of electricity for the reasons stated above.

The writer of this letter thinks that more co-operation is urgently wanted between the various makers of internal combustion engines to ensure that the economies obtained by the use of such engines are properly recognised, and that the present grandiose electricity policy is adjusted to allow of more economical and immediate developments. H. T. DAY.

7, Grosvenor-gardens, S.W. 1,
November 19th.

BELFAST UNION.

SIR,—On the outside page of your issue of November 16th 1923, there appeared an advertisement from the Clerk to the Belfast Board of Guardians. This invited the consulting engineer to deposit a fee of five guineas for the privilege of being informed what this Board of Guardians were proposing to do. Having obtained these details, he was to visit Belfast at his own expense to make further investigation, and then to prepare a detailed scheme for central heating and electric lighting. A bait of one hundred guineas was dangled before the eyes of the prospective applicants in the following terms:—"The Guardians will subsequently decide which is the best scheme submitted, and the person or firm submitting same will be paid the sum of one hundred guineas." Not a word about a technical assessor, not a syllable about the appointment of the successful competitor as consulting engineer to carry out the works, at fees acceptable to the profession.

Had such an advertisement appeared in the architectural papers, the R.I.B.A. would promptly have banned the proposed competition. Surely the Ministry of Health and the councils of the great engineering institutions can be induced to protect the interests of the engineering profession. C. E.

Westminster, November 19th.

British Empire Exhibition: Conferences.

THE programme of conferences to be held during the course of the British Empire Exhibition at Wembley next year is steadily growing. Already some twenty important conferences have been arranged and definite dates assigned for them. Chief on the list are probably the International Advertising Convention, which is to be held during July, the first World Power Conference, which the British Electrical and Allied Manufacturers' Association is organising, and the Mining and Metallurgical Conference in which the principal organisations connected with the Mining Industry, the Institution of Mining Engineers, the Institution of Petroleum Technologists, the Mining Association of Great Britain, the Iron and Steel Institute, the Institute of Metals, the National Federation of Iron and Steel Engineers, are taking part.

Three conference halls, which are now well on the way towards completion, are being built at Wembley. They can accommodate respectively 200, 600 and 1800 people.

The following bodies have now been definitely given dates for the conferences they are arranging:—

British Engineers' Association	April 30.
International Council of Women	May 2.
Town Planning Institute	May 5 to 10.
British Engineers' Association	May 21 and 22.
Imperial Studies Committee of the Royal Colonial Institute.	May 26 to 31.
Institute of Mining and Metallurgy	June 3 to 6.
Textile Institute	June 10 to 12.
Society of Dyers and Colourists	June 11 and 12.
Electrical Contractors' Association	June 18.
League of Nations' Union	June 16 to 21.
British Electrical and Allied Manufacturers Association—World Power Conference	June 30 to July 12.
Thirty Club: International Advertising Convention	July 14 to 19.
Museum Association	July 21 to 26.
British Chemical Association	July 10.
British Engineers' Association	September 17.
Sir Dennison Ross' Committee, Conference on Religions of the Empire	September 23 and 26.
Decimal Association	October 1.
British Engineers' Association	October 15 and 16.
International Council of Women	October 27 and 28.

Arrangements have been made between the British Science Guild and the National Joint Council of the Trade Union Congress and the Labour Party, to hold a Conference on Science and Labour on July 31st and August 1st and 2nd.

The following bodies are arranging conferences for which dates have not yet been definitely fixed:—Incorporated Federated Associations of Boot and Shoe Manufacturers, Women's Settlement—Canning Town East, National Savings Committee, Health Propaganda Association, Royal Society for the Protection of Birds, Y.W.C.A., Institution of Naval Architects, Institution of Automobile Engineers, and Institute of Sanitary Engineers.

The Horace Plunket Foundation, in association with the Presidents of the English, Irish, Scottish and Welsh Agricultural Organisation Societies, is organising a Conference on Agricultural Co-operation.

AT some of the busier stations the Underground management has introduced an "audible interval indicator" in its lift service. These instruments are set to a predetermined time and sound when the lift has been standing at either the upper or lower level a certain number of seconds. The liftmen and public are so advised that the lift must start.

The Scott-Still Marine Oil Engine.

No. I.

CONSIDERABLE interest has been created in marine engineering circles by the series of demonstration trials which during the last ten days have been carried out at the works of the Scott's Shipbuilding and Engineering Company, Limited, at Greenock. The engine which was shown there under test conditions, and which we had the pleasure of inspecting on Wednesday last, is one of two sets of machinery of the Scott-Still type, which the firm has constructed to the order of Alfred Holt and Company, of Liverpool. This twin-screw propelling machinery is designed to develop 2500 total shaft horse-power, each four-cylinder engine developing half this power when running at a speed of 120 revolutions per minute. It is to be installed in the motor ship Dolius, now approaching completion. The ship has the following principal dimensions:—Length, 400ft.; beam, 52ft.; depth, 32ft.; with a displacement of 11,650 tons and a service speed of 11 knots.

These engines are noteworthy because they are the first commercial Scott-Still marine engines to be completed and tested, and some account of their design and performance, and the results which may be expected from them at sea, will be of interest to our readers.

Particulars have already been published with regard to the experimental single-cylinder unit, built by Messrs. Scott, which was described in detail in a paper read before the Institution of Engineers and Shipbuilders in Scotland, by Mr. Archibald Rennie, on February 14th, 1922. In dealing with Mr. Rennie's paper in our issues of February 17th and 24th of last year, we also published a report of Captain H. Riall Sankey's, in which full particulars were given of the thermal efficiences and efficiency ratios of the combustion and steam cylinders, with curves and tables. In March of the present year a further paper was read before the Institution of Engineers and Shipbuilders in Scotland by Mr. A. I. Nicholson on "Some Oil Engine Experiments." This very practical paper gave some of the careful experimental research work undertaken in connection with the experimental and commercial engines. The main subjects dealt with were: Leakage of oil at fuel pump plunger packings, mechanical efficiency and engine friction, and fuel injection experiments, embodying the relations of the atomisation, the penetration and the distribution of the oil in the engine cylinder. The important subject of detonation was touched upon, and an account was given of the effect of different piston-crown shapes on the scavenging of the cylinder.

Turning to the no less important question of the weight of Scott-Still engines and the space occupied, some interesting figures were given in connection with a symposium on marine oil engines, which was held by the North-East Coast Institution of Engineers and Shipbuilders in Newcastle early this year. In our issue of January 19th the different schemes put forward by the marine oil-engine builders for a standard single-screw ship were summarised, and the drawing of the Scott-Still arrangement was reproduced. It is of interest to recall that the total fuel oil bill per 1000 miles was 10 per cent. below the next lowest claim put forward and 20 per cent. under the heaviest fuel consumption submitted in connection with the schemes. In the matter of engine-room space the Scott-Still proposal only required 31ft. 10½in. as against the 48ft. 10in. allowed. With regard to power developed for a given weight, comparing six schemes, including four-cycle, two-cycle, and opposed piston engines, with shaft horse-powers varying between 1828 and 1760, and inclusive weights between 414 tons and 550 tons, the Still engine put forward offered the highest shaft horse-power of 1870, with the lowest total weight of 375 tons. These are important claims to make for any system, and the forthcoming report of the Oil Engine Committee appointed by the Institution of Mechanical Engineers and the Institution of Naval Architects on the tests it has recently made will be awaited with the keenest interest, for this report will not only include test bed trials, but will also deal with results obtained under sea-going conditions.

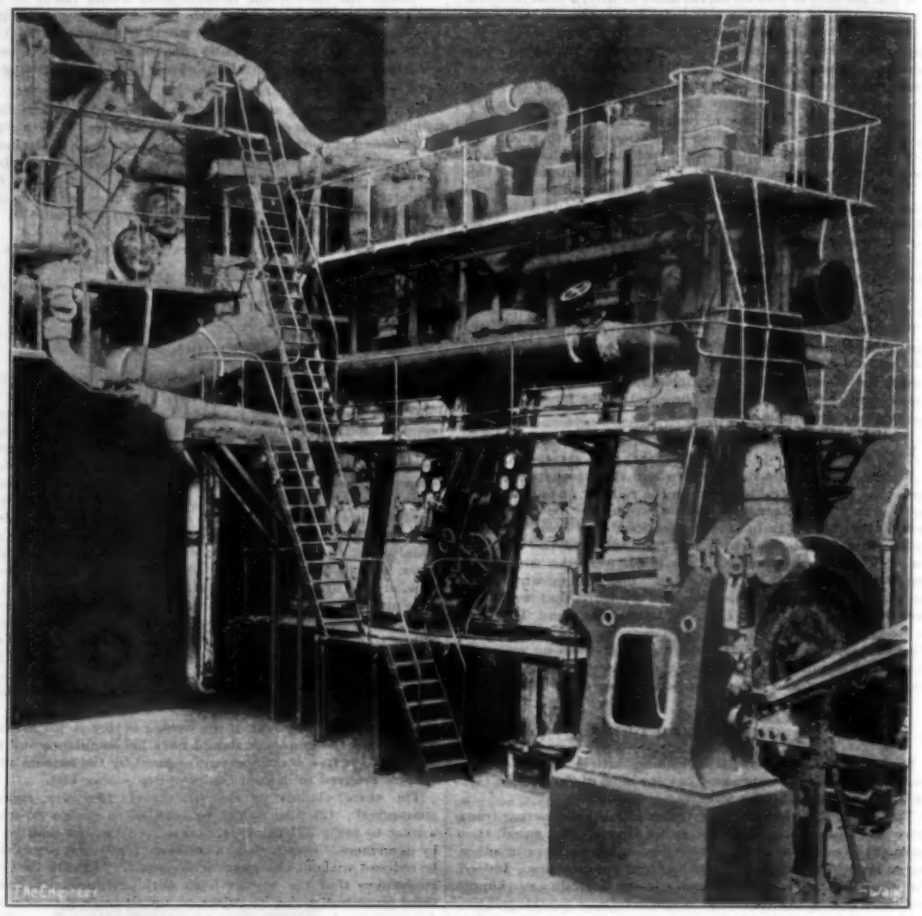
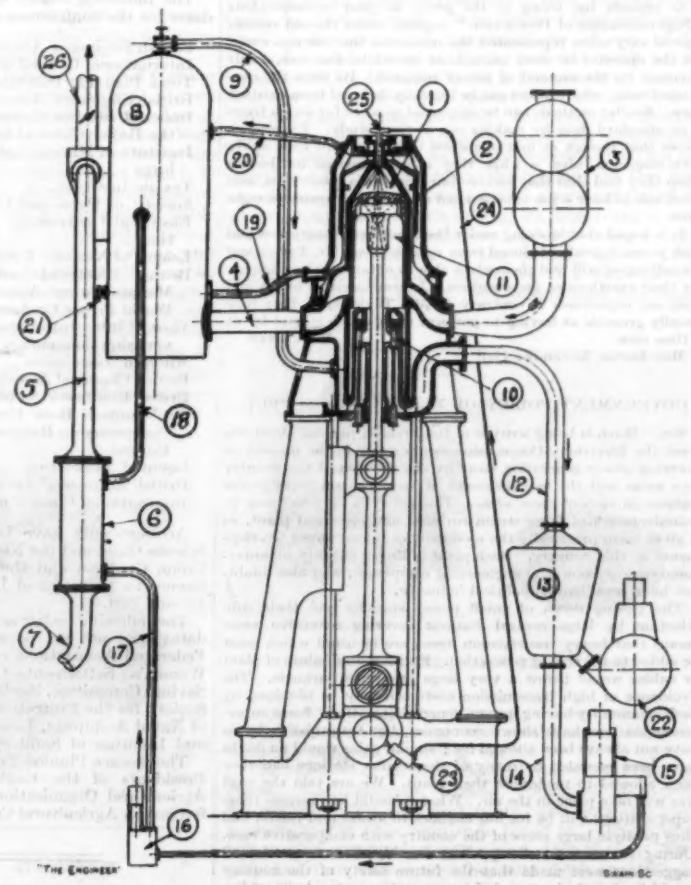


FIG. 2—1250 S.H.P. SCOTT-STILL ENGINE ON TEST BED



REFERENCES.

1. Combustion Cylinder.
2. Reinforcing Steel Hoop.
3. Scavenge Blower.
4. Combustion Exhaust passing through Regenerator to Boiler.
5. Combustion Exhaust Pipe to Feed Heater.
6. Feed-water Heater.
7. Final Combustion Exhaust to Atmosphere.
8. Boiler.
9. Main Steam Pipe.
10. Steam Inlet and Exhaust Valves.
11. Steam Cylinder.
12. Steam Exhaust to Condenser.
13. Condenser.
14. Suction to Air Pump.
15. Air Pump.
16. Feed Pump.
17. Delivery Pipe to Feed Heater.
18. Hot Feed to Boiler.
19. Circulating Water, Boiler to Cylinder Jacket.
20. Circulating Water and Steam, Jacket to Boiler.
21. Auxiliary Oil Burner.
22. Condenser Circulating Pump.
23. Oil Fuel Injection Pump.
24. Oil Fuel Delivery to Injection Valve.
25. Injection Valve.
26. By-pass for Burner Gases.

FIG. 1—DIAGRAM SHOWING THE PRINCIPLE OF THE STILL ENGINE

THE MAIN ENGINES OF THE DOLIUS.

The general principle upon which the Still system depends for its operation is conveniently illustrated in the diagrammatic drawing reproduced in Fig. 1. This shows the relation of the oil combustion and steam cylinders and the means adopted for furnishing scavenging air and receiving the heat of the exhaust gases in the exhaust regenerator, the boiler and the feed-water heater. The illustration we reproduce in Fig. 1 is diagrammatic in character, and has reference only to a single-cylinder unit. The way in which the basic principles of the Still system have been worked out and applied to the engines of the Dolius is illustrated in Fig. 2, which shows the starboard engine on the test bed. Although the engine we saw under test was the port engine, the starboard engine was more conveniently placed for the purpose of photographing, and the views used in this article represent the starboard engine. The view referred to, with Figs. 5, page 557, serves to indicate the relation of the feed-water heater and the boiler to the main engine. It will be noted that the boiler is of the Yarrow type with a single nest of tubes, and is fitted with auxiliary burners for oil firing. The exhaust gases, after giving up some heat to exhaust generators attached direct to the cylinder casings at the back of the engine, are led through a lagged main to the boiler, where, after passing through cross tubes arranged in the lower drum, they enter the feed-water heater and give up further heat before passing to atmosphere. Steam is raised in the boiler at a pressure of 140 lb. per square inch. The engine works on the two-stroke cycle with turbo-blower scavenging, power being developed in four cylinders, each having a diameter of 22in. and a piston stroke of 36in. At the normal rating, 1250 shaft horse-power is developed at a speed of 120 revolutions per minute, this corresponding to a brake mean effective pressure of 75 lb. per square inch, which is obtained with an indicated combustion mean effective pressure of about 79 lb. per square

1250 S.H.P. SCOTT-STILL MARINE ENGINE

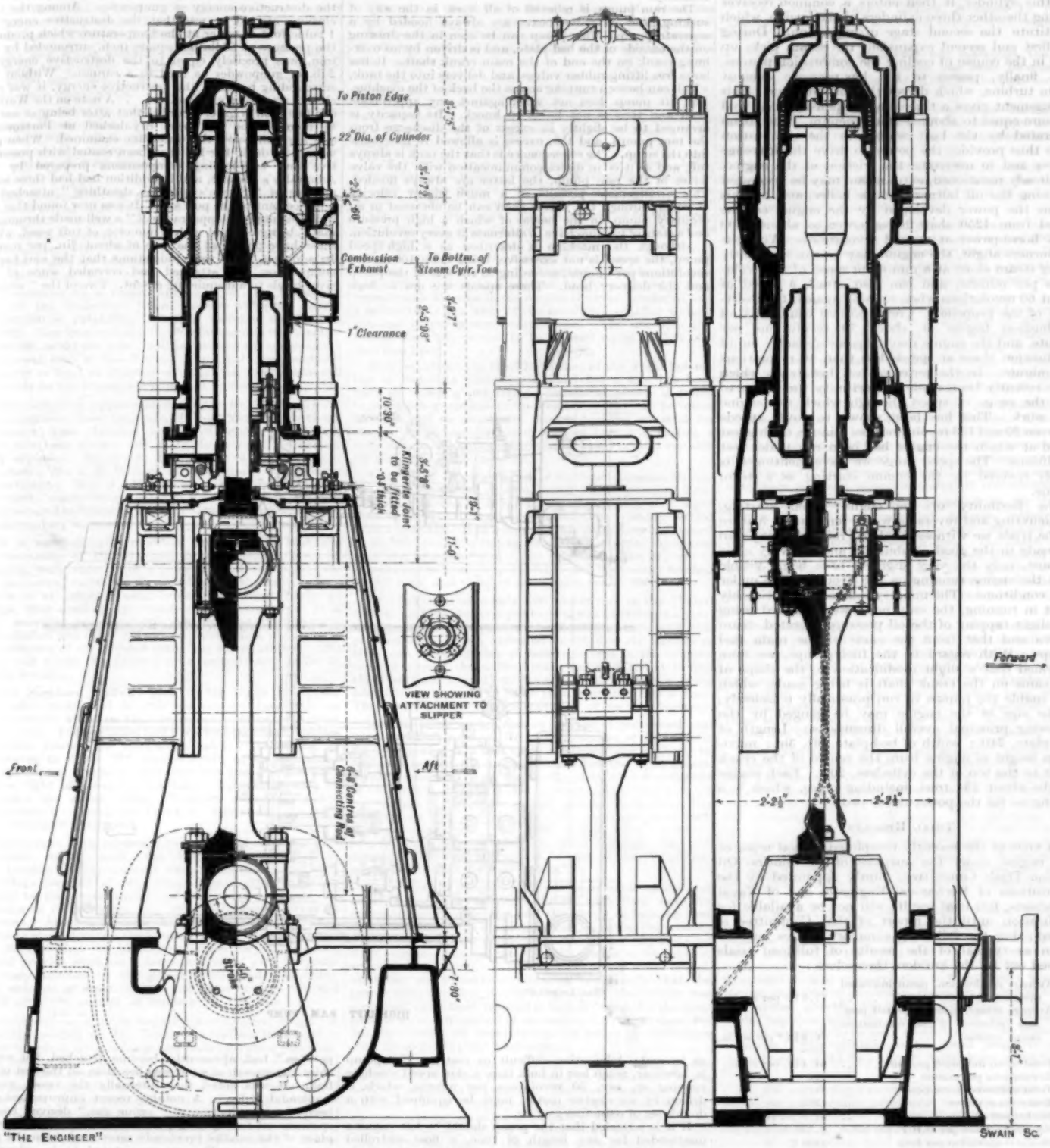


FIG. 3—VERTICAL SECTIONS AND ELEVATION

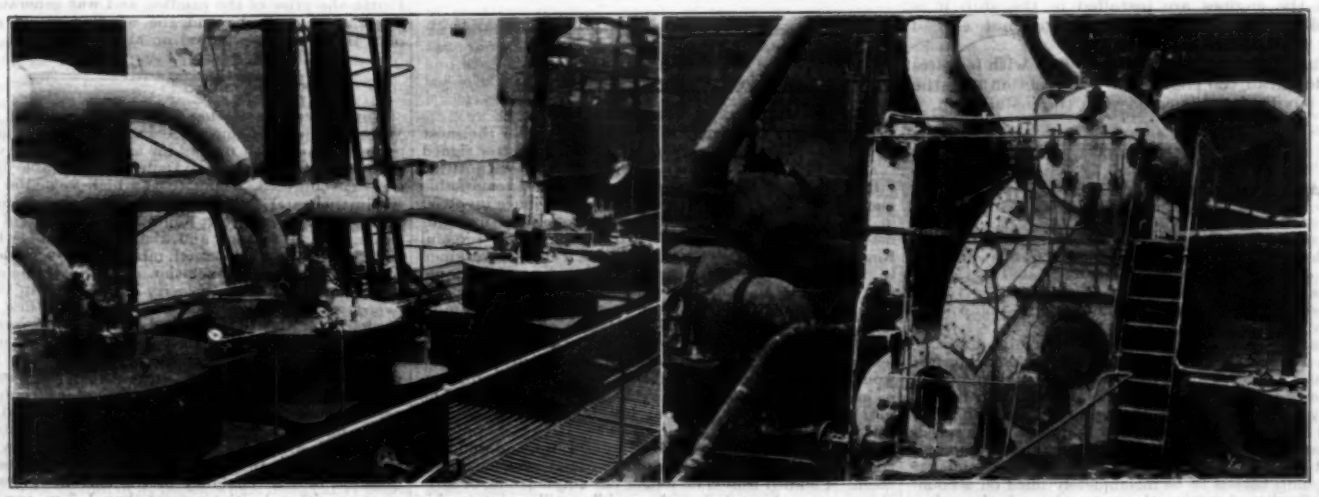


FIG. 4—TOP PLATFORM AND CYLINDER HEADS

FIG. 5—BOILER AND REGENERATOR

inch. On the steam side, the boiler steam at 140 lb. pressure passes to the underside of the after cylinder, which acts as a high-pressure steam cylinder. Leaving this cylinder, it then enters a common receiver joining the other three cylinders of the engine, which constitute the second stage of expansion. During the first and second expansions the steam picks up heat in the course of cooling the combustion pistons, and, finally, passes to the low-pressure exhaust steam turbine, which drives the turbo-blower. This arrangement gives a three-stage expansion to a final pressure equal to about a 28in. vacuum. The steam generated by the heat wasted in the combustion cycle thus provides the power to drive the scavenge blower and to overcome the friction of the engine. As already mentioned, extra steam may be generated by using the oil burners on the boiler, and by this means the power developed by the engine can be raised from 1250 shaft horse-power to about 1500 shaft horse-power at normal revolutions. With the oil burners alight, the engine may be run constantly under steam alone at a minimum speed of 20 revolutions per minute, and can also attain a speed of about 60 revolutions when running against the resistance of the propeller. Under normal conditions oil combustion begins at about 30 revolutions per minute, and the engine may be run constantly on oil combustion alone at speeds less than 40 revolutions per minute. In the series of test bed trials which have recently been made, opportunity was given to test the range of speed through which the engine will work. This has been shown to cover speeds between 20 and 135 revolutions per minute, the highest speed at which the engine has been run under test conditions. The speed range we have mentioned is amply covered by the engine starting as a steam engine.

The flexibility of the engine when starting, manœuvring and reversing was a remarkable feature of the trials we witnessed. Brief reference may also be made to the good combustion and the very clear exhaust, only the very slightest haze being visible with the engine running on the Froude brake under load conditions. The main cylinders were noticeably quiet in running, the only noise we remarked being the slight tapping of the oil pressure operated steam valves and that from the cams of the main fuel pumps. With regard to the fuel pumps, we were informed that a slight modification to the shape of the cams on the crank shaft is being made, which will enable the pumps to run practically noiselessly.

The size of the engine may be gauged by the following principal overall dimensions:—Length of bed-plate, 24ft.; width of bed-plate, 9ft. 3in.; maximum height of engine from the centre of the crank shaft to the top of the cylinders, 20ft. Each engine weighs about 134 tons, including pipes, which is a low figure for the power developed.

Trial Results.

In view of the recently completed official trials of this engine under the auspices of the Marine Oil Engine Trials Committee, jointly appointed by the Institutions of Mechanical Engineers and of Naval Architects, full trial results will not be available for publication until the report of that Committee is issued; but the following summary figures may be taken as typical of the results of full-load trials carried out by the builders themselves:—

Average combustion, mean indicated pressure	77.8 lb. per sq. in.
Average steam, mean indicated pressure (referred to the combustion swept volume)	6.6 lb.* per sq. in.
Total mean indicated pressure	84.4 lb. per sq. in.
Revolutions per minute	122
Total indicated horse-power	1425
Brake horse-power	1251
Mechanical efficiency	87.8 per cent.
Oil consumption per B.H.P. per hour	0.356 lb.
Steam evaporation per hour	2400 lb.

* Note.—This does not include the third-stage expansion in the low-pressure turbine driving the scavenge blower.

When the engines are installed in the ship it is expected that the fuel consumed will not exceed 0.36 lb. per shaft horse-power.

In a further article we propose to deal with features of the design of the engine, its construction and the various auxiliaries connected with the installation.

A New High Lift Pump.

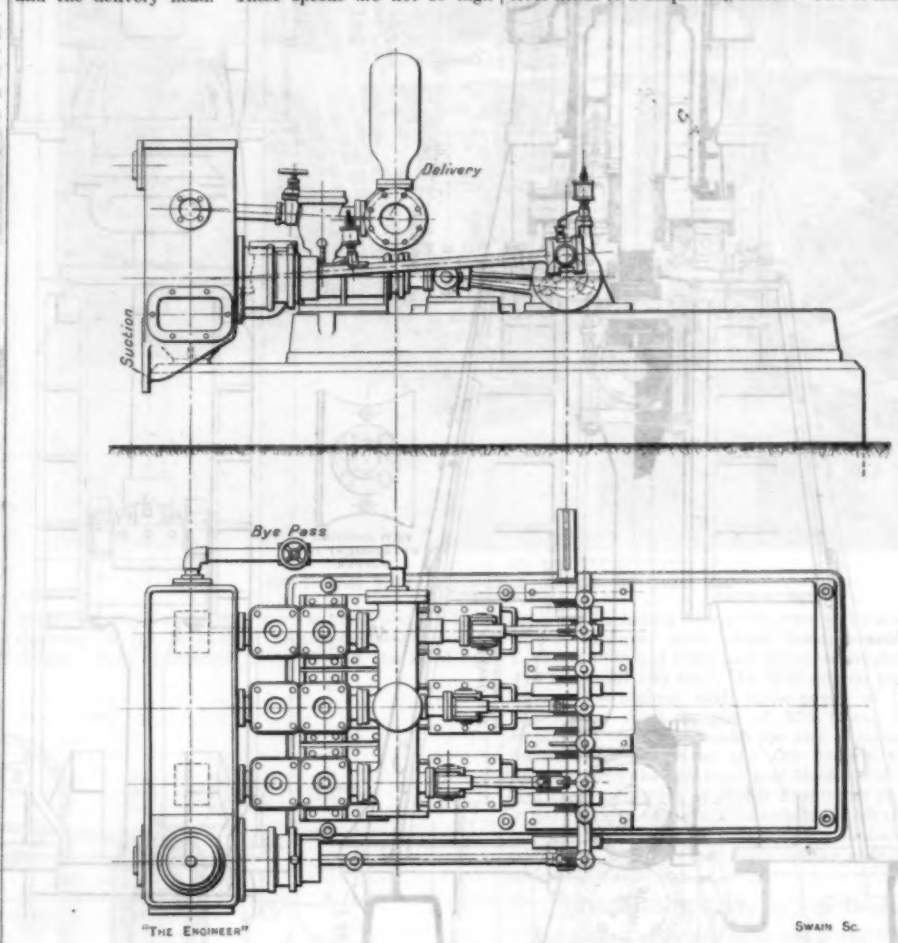
With the object of providing a ram pump for working against heavy heads, that can be run at speeds considerably in excess of those generally associated with this class of machinery, Lee, Howl and Co., Limited, of Tipton and London, have recently brought out the pump illustrated by the drawing given herewith.

The pump is intended for such services as mine drainage, and it is naturally an advantage to run it reasonably fast as a greater delivery can be obtained for any given overall dimensions, and the size of the pump chamber can, consequently, be reduced. In the past, however, difficulty has been experienced in running ram pumps at high speeds on account of their knocking. As the sump is pumped out, and the suction head increases, there is a tendency for the pump barrels to be incompletely filled on account of the difficulty of getting the water through the valves fast enough. With an incompletely filled barrel, the ram knocks hard against the water at each stroke, to the obvious detriment of the machine. A very simple expedient has enabled Messrs. Lee, Howl to overcome this difficulty.

The ram pump is relieved of all work in the way of sucking, and its valve boxes are always flooded by a separate pump. This pump can be seen in the drawing on the outside of the bed-plate, and is driven by an overhung crank on the end of the main crank shaft. It has large free lifting rubber valves, and delivers into the tank, which can be seen running across the back of the machine. The lift pump does not work against any appreciable head and thus is not liable to knock. Its capacity is arranged to be slightly in excess of the discharge from the ram pumps, and this excess is allowed to flow back into the sump. The consequence is that the tank is always full, and as it is in direct communication with the valve boxes of the ram pump, the latter are always flooded. This arrangement permits of a much higher velocity of water through the valves than can be obtained in an ordinary pump, in the barrel of which a high pressure and a state of vacuum have to alternate at every revolution.

Although the machine is described as a high-speed pump, the speed is not excessive, being from 100 to 200 revolutions per minute, according to the size of the pump and the delivery head. These speeds are not so high as to make lubrication difficult or costly. The pump is, however, much less in bulk than a slow-speed machine running at, say, 50 revolutons per minute, which, if driven by an electric motor, must be equipped with a double set of reduction gearing.

If it is intended that the pump should be left running unattended for any length of time, a float-controlled switch is rigged up in connection with the suction tank, so that the motor will be stopped in the event of the water failing for any reason.



HIGH-LIFT RAM PUMP

Sixty Years Ago.

In our issue of November 20th, 1863, one of the most interesting features was a somewhat lengthy letter signed "T. J. (a Tipton Puddler)." The letter was entitled "Iron Making," and displayed not only a most remarkable insight on the part of its author into the science involved in the puddler's work, but an equally noteworthy command over the writing of clear, correct and forceful English. Yet the writer was a puddler, a class of workmen to whom, or so he said in his concluding paragraph, the most vile epithets were applied, who were despised and neglected, and who were stigmatised as ignorant, reckless, dissipated, and only a degree above the brute creation. He urged that he and tens of thousands of his fellows engaged in "the staple trade of our country" would "hail as a boon any information tending to enlighten us on the nature of our employment." There was a niche in the manufacture of iron, he concluded, which the puddler alone could occupy. The Bessemer process, with all its attributes, had failed to fill it up, and puddlers smiled at the idea that machinery would ever supersede them. Puddled iron is no longer our staple trade, or anything approaching it, but the puddler still maintains his supremacy over the machine, at any rate in this country. . . . In the same issue an article appeared written by the Astronomer Royal—Sir George Airy—describing an attempt to evaluate the destructive energy manifested in steam boiler explosions, and to compare it with the destructive energy of gunpowder. Among the conclusions arrived at was that the destructive energy of 1 cubic foot of water at the temperature which produced the pressure of 60 lb. per square inch, surrounded by hot iron, was precisely equal to the destructive energy of 2 lb. of gunpowder as fired in a cannon. Without the surrounding hot iron, the destructive energy, it was concluded, was exactly halved. . . . A note on the Warrior, our first iron frigate, recorded that after being at sea for 4½ months, she had been dry-docked at Portsmouth and her hull below the water-line examined. When previously in dock, her hull had been coated with preservative and anti-fouling compositions prepared by the Admiralty's chemist, and in addition had had three small patches of "Brown's vitreous sheathing" attached by a hot cement to the port side. It was now found that the hull presented the appearance of "a well-made thrummed-mat," being covered with a fine crop of tuft weed, which must have grown at the rate of about ¼in. per month. In addition, there were indications that the anti-fouling composition had attacked and corroded some of the rivet heads to a disquieting extent. Two of the "vitreous patches" had, apparently, become detached, but on the third the growth of weed was less than on the rest of the hull. It was noted that internally the vessel was in "splendid order." A notable recent improvement had been the introduction of "ozone gas," derived from a spiritous oil for lighting purposes in the engine-room in place of the candles previously served out from the paymaster's stores. The gas was stated to be odourless, both before and after combustion, and to yield a beautiful white light with practically no heat. It cost but one-fourth the price of the candles, and was generated by an apparatus which, beyond the winding up of a weight once in 24 hours, required no attention.

The Controller of the Physical Department and Mr. Watt, resident engineer, Aswan Reservoir, have been experimenting with meters for ascertaining the discharge of the sluices in the Aswan Dam. Considerable difficulties were encountered, owing to the high velocities and the silt in the water, but finally a type of current meter was evolved which has been found to be capable of working throughout a season, and the accuracy of which was tested by means of actual measurements made with a masonry tank. The evolution of the instrument has led to the mapping of the velocity distribution in the sluices over a wide range of conditions, and for the first time the discharge of the Nile in flood has been measured by a method depending ultimately on measurements of volume in a tank. The results obtained are said to be in agreement with the ordinary current-meter measurements made below the dam up to discharges of 9000 cubic metres per second and velocities of 1.7 m. per second. Above those figures there are only four measurements by the ordinary method, all made in 1923, and as they vary by amounts up to 16 per cent. from the sluice results, the question of the reliability of the current meter in deep streams with velocities greater than 1.7 m. per second is being further investigated.

Railway Matters.

The West Riding County Council does not see its way to support the proposed light railway from Longridge—north-east of Preston—to Hellifield.

The new works programme of the Southern Railway includes the building of forty-one new corridor coaches at £2900 per coach—the price of a locomotive engine until quite recent years.

It is proposed to construct a road over New-street Station, Birmingham. The design of the roadway shows a viaduct 80ft. wide to carry heavy traffic; one end of the viaduct would connect with an extension of the road at the bottom of Stephenson-place, the other with Bristol-road.

The electrical rolling stock used in the Euston–Broad-street–Watford and Richmond services is repaired at Wolverton. As that place is outside the electrical area, the coaches are removed from their bogies at Stonebridge Park and sent to Wolverton on temporary bogies. The original bogies are overhauled at Stonebridge Park while the cars are away.

According to a report appearing in the Melbourne *Herald*, the Tramways Board expects to spend nearly £2,000,000 in extending travelling facilities by the end of 1925. New lines will absorb £800,000, and of this amount £480,000, or 60 per cent., will be utilised on works north and north-west of the Yarra. The Board has acquired 16 acres of land at Preston on which to erect what will probably be the largest workshops in Victoria.

The following appointments under Mr. C. J. Brown, chief engineer, Great Central and Great Northern Sections, Southern Area, London and North-Eastern Railway, have now been made:—Mr. S. L. Murgatroyd, permanent way engineer; Mr. R. F. Bennett, chief constructional assistant; Mr. T. B. Willans, chief assistant, construction department; Mr. J. H. Bailey, chief drawing-office assistant, construction department; Mr. J. Gardiner, architectural assistant; Mr. F. Y. Marrian, surveying and parliamentary assistant.

It is semi-officially reported from Nairobi that the Governments of Uganda and Kenya contemplate the floating, very shortly, of a joint loan of £6,000,000 for the purpose of extending the new Uasin Gishu railway line, which is at present being constructed, from Turbo to Jinga, thus opening up valuable cotton country. It is also intended to carry out further port development at Kilindini and other railway improvements, particularly the relaying of the present main line where needed. The loan will mean the placing of a considerable order in Great Britain.

The Southern Railway took to the Court of Appeal the case—mentioned in this column on June 8th—of an employee killed in the Gravesend collision of August 21st, 1922. The workman had a workman's ticket, the use of which limited the company's liability for injury, or otherwise, to £100. Mr. Justice Swift, as we mentioned on the former occasion, said that the man's death gave a new right of action to the man's dependants, and he awarded the widow £800. Without calling upon the respondent's counsel, the Court of Appeal, on the 23rd ult., dismissed the appeal.

Reporting with reference to the urgent need for new tramway rolling stock, the Highways Committee of the London County Council recently recommended that a certain number of four-wheeled cars should, having regard to their mechanical and structural condition, be withdrawn from service and up-to-date bogie cars substituted. About sixty new cars will be required, and in arriving at its decision the Committee has been influenced by the fact that the placing of orders for rolling stock would provide work for a large number of men in trades seriously affected by the present industrial stagnation. The estimate of expenditure is not to be brought forward until after the receipt of tenders for the cars.

Locomotives of larger capacity and modern design are urgently needed on the South Australian Railways in order to reduce train mileage and train operating expenses, and designs have been prepared for three types. All three of these types represent the latest locomotive practice, and it is expected that their operation will be attended with much greater economy than is possible with the existing engine power. The designs have been prepared with a view to providing in each case a locomotive exactly suited to the service requirements, and include a "Mountain" type (4–8–2) of 51,000 lb. tractive effort for the Melbourne express on the Adelaide–Murray Bridge section, and also for heavy freight service. For fast schedules on the Southern and Northern expresses, a "Pacific" (4–6–2) type of 37,000 lb. tractive effort has been designed, while for freight service on 60 lb. rails a "Mikado" (2–8–2) of 40,000 lb. tractive effort is proposed.

It was twenty-three years on Sunday, the 11th inst., since the celebrated Norton Fitzwarren accident. Here a down narrow-gauge goods train was shunted on to the up main line to allow a more important down train to precede it. The standing train was then forgotten by the signalman, and an up special broad-gauge express, travelling at high speed and conveying passengers and mails that had arrived at Plymouth that afternoon from South Africa, was accepted and the signals lowered for it. In the collision that ensued, ten passengers were killed. The enginemen with the goods train had failed to reverse their head lights or the express would have been warned, and the guard did not go to the signal-box to remind the signalman. The accident gave rise to many inventions of what became known as "crossover locking," *i.e.*, locking that came into force when a shunting movement was made and which remained when the levers were reversed and until a subsequent movement was made to dispose of the shunted train. It also led to the provision of more refuge sidings into which trains could be shunted instead of their occupying one of the running lines. The Norton Fitzwarren accident was inquired into by Colonel Rich, the brevity of whose reports was notorious. This collision was dealt with by him in 3¼ pages, which included 1¼ pages for the evidence. His conclusions filled only three-quarters of a page.

Notes and Memoranda

Writing in the *Canadian Mining Journal*, Mr. Alexander Gray states that the gold ore reserves of Hollinger Consolidated mines will have an estimated value of between 60,000,000 dollars and 63,000,000 dollars at the end of this year.

Bulletin No. 1, which has just been issued by the Department of Heating and Ventilating Engineering of the University of London, contains an extensive report on research into the effect of the shape and surroundings of a hot surface on the radiation from it by Messrs. A. H. Barker and M. Kinoshita.

The recently completed dam at the Great Lake, Tasmania, has a height of 40ft., and provides a storage of 312,500 million gallons over an area of 60 square miles, which, it is claimed, makes it the fourth largest reservoir in the world. The power plant is already of 50,000 horse-power capacity, and is to be extended by another 10,000 horse-power.

Tests carried out by Messrs. J. J. Denny and R. B. Watson, of the Nipissing Company, Canada, on tube mills lined with rubber instead of iron, showed a very considerable increase in the output of ground material, and a reduction in the wear of the grinding balls, but a slight increase in the power consumption. The life of a ¾in. rubber liner was proved to be at least equal to that of a 2in. iron liner.

It is reported from Stockholm that at the works belonging to Baastads Kalkindustriaktiebolag a kiln has been built in which a pulverulent limestone, which is found in enormous quantities in the Basstad region, can be transformed into an extremely strong binding material for mortar or bricks. The new product has, it is stated, a very clean white appearance, which makes it most suitable for plastering of ceilings, &c.

The output from the mines of the South Russian Mining Trust for the twelve months ended with September 30th, 1923, is returned at 165,000 tons of iron ore, or 3.4 per cent. in excess of the tonnage fixed in the schedule settled over a year ago. The output of manganese ore amounted to 91,000 tons, or a falling off of 7.6 per cent., compared with the tonnage fixed in the schedule. The exports of iron ore in the financial year ended with September reached 12,000 tons, and those of manganese ore 44,000 tons.

In 1895 there were only 300 motor cars in the United States. In 1905 the total production was 24,000 cars a year. Last year the production was 2,659,064 cars, and this production had been exceeded in the first six months of this year. The number of cars registered in the country did not exceed the million mark until 1913, but to-day there are more than 13 millions, and this number is being added to at the rate of more than a million cars a year. The Ford works are doing 55 per cent. of the total business.

In concluding an address on the use of pulverised coal in open-hearth furnaces, Mr. R. H. Lowndes, of the Atlantic Steel Company, said that there is but one way correctly to evaluate pulverised coal as a fuel for the open-hearth furnace, and that is to watch the industry for a decade or two longer. With the ever-increasing improvements for overcoming of difficulties as they present themselves, this type of fuel may indeed come to be more and more used in open-hearth work. But at the present time it is necessary to state that the Atlantic Steel Company has just discarded its coal-fired furnace because of the higher cost of producing steel by that means.

In view of the progress in recent years in the design and construction of hydraulic turbines, with their sensitive automatic control devices and the nicety of balance that is now attained, it is a decided shock, says the *Engineering News-Record*, to hear of a large unit being actually installed with something so far wrong in its design as to prevent successful operation. A 40,000 horse-power water wheel, on being put in service, vibrated so seriously that the power company shut it down, but finally the trouble was corrected, or at least reduced it to safe limits, by the comparatively rough method of decreasing the runner diameter 5in. by cutting off metal around its entire circumference with an oxy-acetylene blow-pipe.

The value of interconnection between large power transmission systems is exemplified by an incident which recently happened in America. The small reservoir of the Alabama Power Company on the Coosa River was full, and so could not conserve a flood flow. The flow could be utilised, if at all, only as it came down the river; but away off to the east, on the eastern slope of the Piedmont Plateau, the reservoir of the Carolina Power and Light Company, on the Pee Dee River, had been drawn down, and an insufficient stream flow meant a shutting down, or at least curtailing of output, of the many cotton mills dependent on this water power. Consequently, for a time the turbine gates on the Pee Dee River were closed; and while the reservoir was thus allowed to be replenished, the load of the company was carried by power relayed to it by the Southern Power Company, which, in turn, received it from the Georgia Railway and Power Company, to whom it was delivered by the Alabama Power Company.

According to some elaborate tests carried out by the American Society of Testing on the painting of iron and steel, the following points have been developed:—(1) The thorough methods of preparation, *i.e.*, sand blasting and picking, show no superiority over ordinary methods of removing loose scale, rust and dirt by scraping, brushing and wiping. This applies to both new steel and old steel which has been in service. (2) Weathering to permit loosening and partial removing of mill scale before painting is inimical to preservation. (3) Painting in a cold dry atmosphere gives results as good as in warm dry atmosphere, or on heated steel. (This may be due to the greater thickness of coatings applied in the cold atmosphere.) (4) The preparation of old painted steel surfaces, which have bare rusted spots, by brush coating with benzine over and around the rust spots, burning the benzine off and then scraping and wire brushing, gives better results than scraping and wire brushing without the benzine treatment and better results than sand blasting. (5) There is no difference observable in the results of the application of the same methods to old and to new steel.

Miscellanea.

The London County Council proposes to replace Lambeth Bridge by a steel arch bridge, 60ft. wide, at a cost of some £668,000.

Since last year's grain crop was marketed, the grain storage capacity of Vancouver has been increased to 3,500,000 bushels, as against 1,250,000 bushels last crop year.

The production of coal in Yugoslavia during 1922 amounted to 4,000,000 tons and that of copper to 8500 tons. This year's results promise to be better than those of last year.

The announcement is made that the Crompton Medal for the session 1922–23 has been awarded by the Institution of Automobile Engineers to Mr. E. B. Wood for his paper on "Sleeve Valve Engines."

The Hartlepool Harbour Commissioners are considering a scheme for making, at an estimated cost of £600,000, a new outer harbour by lengthening the existing Hartlepool breakwater, and the construction of a pier about a mile from West Hartlepool, enclosing a water area of about 250 acres.

A branch of industry that has hardly yet been touched in South Africa, and which it is intended to develop at an early date, is the cultivation of the *hibiscus cannabinus* and other fibres of the same class which can be grown in the same area as sisal, or Mauritius hemp. The *hibiscus cannabinus*, which, in the past, was regarded as a noxious weed, thrives naturally in many parts of South Africa.

A scheme has been prepared for the establishment of ironworks in the South-East of Borneo. Under an agreement entered into between the Government of the Dutch East Indies and the promoters of the new venture, the company being formed is granted a working concession until the end of the century, and will be allowed to establish a suitable port and adequate transport communications.

A scheme, which has been proposed by Sir William Tritton for the improvement of Lincoln, includes the improvement of three bridges in the city—Brayford Head, the High and Melville-street Bridges. The depth of the Witham is to be made 3ft. 6in. between Brayford Head and Stamp End. The lock at this latter position is to be removed, and replaced by a lock at Brayford Head. The present swing bridge at Brayford Head is to give place to a wide fixed structure.

One of the largest dry docks in the world was recently officially opened at St. John, N.B. The overall length of the dock is 1150ft., the clear width at the entrance is 125ft., with 42ft. of water from floor to sill at extreme high tide. The dock is divided into two chambers, the inner 500ft. long, and the outer dock 650ft. long, so that accommodation can be provided for two moderate sized ships at one time, or one large vessel. There is also in connection with the dock a fully equipped repairing plant.

It is understood that the Reconstruction Budget Committee's report provides for a total expenditure for Tokio and Yokohama of 705 million yen over a first period of six years ending in April, 1929. The work will be spread over several periods in order to avoid, as far as possible, the necessity of a foreign loan. The estimates cover the cost of roads, canals and parks, and also subsidies for assisting industries, rebuilding public buildings, and interest on long-term municipal loans. It is stated that the second term of expenditure will cover the cost of the aerial defence of the capital and also of underground railways.

A comprehensive work entitled "Forest Resources of the World," consisting of two volumes of about 1000 pages in all, and containing a discussion of the general forest situation of the world and the forest resources of each country, has recently been published in America. Questions such as those relating to forest areas, standing timber, character of ownership, character of forests, annual cut, annual growth, domestic consumption, and export trade, together with the future outlook and other important subjects, have been treated under the respective countries. This publication has been prepared under the authority of the Secretary of Agriculture of the United States.

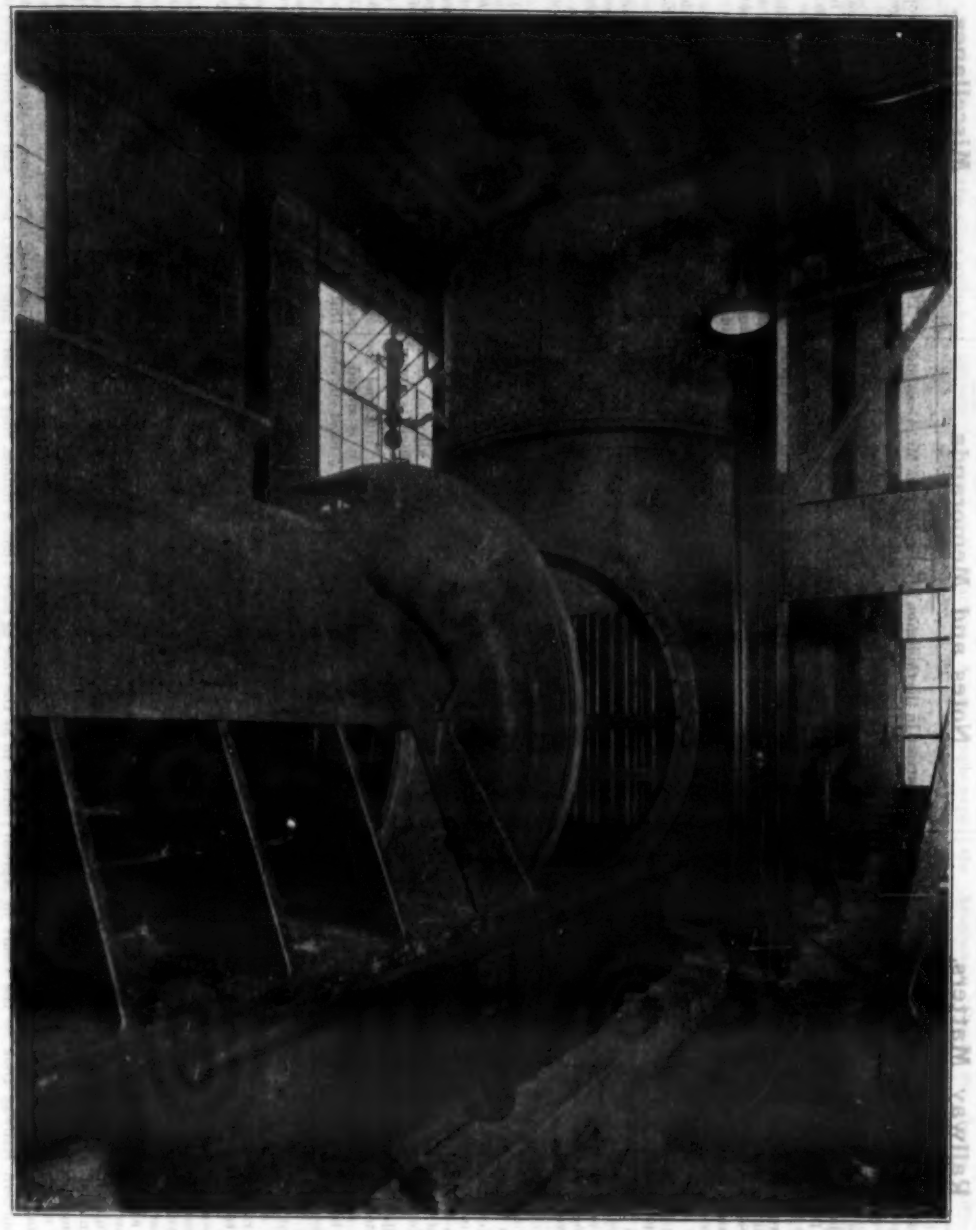
At the air demonstration given to Dominion representatives at Croydon aerodrome recently, the methods employed in the daily routine of the aerodrome were shown by means of the Marconi Company's aeroplane—representing a commercial machine flying on the continental air route—and two Marconiphone loud speakers arranged near the control tower in such a manner that the orders given to the aeroplane and the pilot's replies could easily be followed by the whole gathering. The calling up of the machine, requests by the pilot for a bearing, landing directions, &c., evoked much interest. After landing, the machine taxied along the ground to the place where the Imperial representatives were gathered, so that they might examine the Marconi telegraph and telephone apparatus, which is typical of that carried on all English commercial aeroplanes. By its means conversations have been carried on between a pilot and the aerodrome up to a distance of 400 miles.

A development of the use of gas in industry—the firing of coppers in which beer is boiled at breweries—was described in a paper read at the twelfth annual conference of the British Commercial Gas Association by Mr. William Wilson, engineer and manager of the gas department at Burton-on-Trent, where experiments with the new method were first made in the model brewery of Samuel Allsopp and Sons, Limited. The normal capacity of the copper with which the tests were made was not less than 80 barrels, or 2880 gallons. The wort, the extract of malt, began running in at a temperature as near 145 deg. Fah. as possible, and as soon as the copper bottom was covered two of the gas burners were lighted, the remainder being brought into action gradually as the copper filled. In about three hours' time, when the copper was full, the whole of the contents was boiling vigorously—and was kept boiling for about four hours. It is claimed that the advantages of obtaining the necessary heat by gas instead of coal are chiefly convenience and cleanliness.

MERCURY VAPOUR STEAM TURBINE PLANT AT HARTFORD, U.S.A.

(*For description see page 563*)

1800 K.W. GENERATOR, TURBINE AND MERCURY CONDENSER



PLANT WITH TURBINE WHEEL REMOVED SHOWING MERCURY CONDENSER TUBES

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Postal Address, 33, Norfolk-street, Strand, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Telephone Nos. 2258, 2257 Central.

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Contents.

The Engineer, November 23rd, 1923.	PAGE
A Seven-day Journal	547
Short Histories of Famous Firms.—No. XVII. (Illus.)—Kitson and Co., Limited, Leeds	548
Ship Form and Steering.—No. I. (Illus.)	551
The History and Progress of Metallurgical Science.—No. IV. (Illus.)	552
The Wireless Exhibition.—No. III. (Illus.)	553
Letters to the Editor—	
One-wire and Three-wire Systems for Railways	554
The Geared Drive	555
The Piecework System	555
Government Policy of Electricity Supply	555
Belfast Union	555
British Empire Exhibition: Conferences	555
The Scott-Still Marine Oil Engine.—No. I. (Illus.)	556
A New High Lift Pump. (Illus.)	558
Sixty Years Ago	558
Railway Matters—Notes and Memoranda—Miscellanea	559
Leading Articles—	
The Mercury-Vapour Prime Mover	561
Locomotive Driving	562
Joint Patentees	562
Institution of Mechanical Engineers. (Illus.)	563
Public Works and Transport Congress	565
Paddy Husks for Boiler Fuel	566
Large Bridge-erecting Cranes for India. (Illus.)	566
The "Brama" Annual Dinner	567
Timber in Eastern Asia	567
Launches and Trial Trips	567
Contracts	567
A 12,000-Volt Direct-current Generator. (Illus.)	568
A Small Motor Cruiser. (Illus.)	568
Provincial Letters—	
The Midlands and Staffordshire	569
Lancashire	569
Sheffield	570
North of England	570
Scotland	571
Wales and Adjoining Counties	571
The Institution of Civil Engineers	571
Current Prices for Metals and Fuels	572
French Engineering Notes	573
British Patent Specifications. (Illus.)	573
Catalogues	574
Forthcoming Engagements	574
Personal and Business Announcements	574

THE ENGINEER.

NOVEMBER 23, 1923.

The Mercury-vapour Prime Mover.

The fact that steam is not by any means an ideal fluid for employment in prime movers has long been appreciated. On the one hand, although theory indicates and practice permits the raising of the initial temperature of the working fluid as a means of increasing the efficiency, we are faced with the fact that long before the temperature which we desire to reach is attained, the corresponding pressure becomes prohibitively great. On the other hand, at the temperature corresponding to that of the circulating water in a condenser, the pressure is so low and the specific volume so great that in a reciprocating engine it is practically impossible to take complete advantage of the full vacuum available, while in reaction turbines it becomes a matter of great difficulty to provide the necessary area for the flow of the steam in the lower stages. In his paper on binary-fluid turbines, presented last Friday evening before the Institution of Mechanical Engineers, Mr. Kearton gave an indication of the properties required of an ideal working substance, but he hastened—too quickly, it perhaps may yet be discovered—to add that there was no such fluid in existence. In turning to the binary-fluid principle as a possible way out of the difficulty, engineers are seeking a compromise. There is no virtue, indeed from many points of view there is a considerable lack of virtue, in using two fluids in place of one. The sole advantage arises from the fact that by adopting the binary-fluid principle, we can split the working range into a high and a low part, for each of which a separate fluid best suited to the different conditions of the two portions may be adopted. For various reasons, attention in recent years has been given almost exclusively to the employment of mercury vapour in the high temperature portion of the range and of steam in the low. The success with which the application of the binary-fluid principle has been applied in practice—if we make an exception of the Still engine, which may be classified as a form of binary-fluid prime mover—has not been strikingly great, although the idea has been in the minds of engineers for over seventy years. On the practical side, the outstanding example of the use of mercury vapour as the second working substance is that provided by Mr. W. L. R. Emmet in the United States. In this instance, however, we find secrecy still preserved regarding the results achieved, but hear reports of long years of effort to bring the idea to the first stages of experimental application, and of many practical difficulties encountered in the first commercial trial of the system. On the theoretical side, we now have Mr. Kearton's very complete study of the subject and the discussion which his presentation of it evoked last Friday to guide us towards the view that even on paper the whole matter is shrouded in doubt and complexity.

There can be but little doubt that the use of mercury as a working substance in a binary-fluid turbine, steam being the other substance, should result in quite a respectable saving of fuel in the production of a given quantity of energy. Subject to specific conditions, theory indicates that the overall thermal efficiency of such a plant from the coal or oil to the turbine shaft should be in the neighbourhood of 32 per cent. That figure, it is true, is less than the efficiencies actually measured in the case of two-cycle and four-cycle solid injection oil engines, and is considerably less than the efficiency recorded for the 400 horse-power experimental Still engine built by Messrs. Scott, of Greenock. Nevertheless, it shows an improvement of some 50 per cent. over the efficiency of an ordinary steam turbine working under comparable conditions. Unfortunately, we have no experimental confirmation for the efficiency figure. Mr. Emmet has published no information on the subject, so far as we know, except a claim that the adoption of his system in a good modern power station would increase the output 66 per cent. for an increase of only 15 per cent. in the fuel consumption, which figures imply an increase of 44 per cent. in the overall efficiency. Even Mr. Robinson, who on Friday night subjected the claims made for the mercury vapour-steam turbine combination to a damaging amount of criticism, admitted that as a result of some calculations he had made, such plant, if used in place of ordinary steam turbines in a station of 10,000-kilowatt capacity, would show a saving of three-eighths in the fuel bill at all load factors, a figure implying an improvement of the thermal efficiency of no less than 60 per cent. Others, it is true, have argued that the efficiency figures indicated are all too optimistic, but on the whole in our present state of knowledge it seems reasonably safe to believe that we may count upon an improvement of at least 40 per cent. But accepting such a figure or even a higher one, we are still faced with the fact that prime movers are in existence to-day in an advanced stage of commercial development which can surpass it. Why, then, trouble to develop a new and less efficient form? Because, reply the exponents of the binary principle, the mechanical form of our prime mover is that of the turbine, which form is ideal for the generation of large outputs. That argument undoubtedly must weigh with us, but its weight is clearly transient, depending as it does upon the fact that the solid injection oil engine has not yet reached its full development in the matter of size. One other advantage which the binary-fluid turbine would appear to possess has not, perhaps, been so far sufficiently stressed, namely, the important commercial consideration of space occupied. From Mr. Emmet's figures, already quoted, it would follow that a given power-house could increase its output by two-thirds, without extension of area except as regards an increase of 15 per cent. in the coal bunkers and coal and ash-handling equipment. Mr. Patchell's remarks support that deduction, for he has told us that at the Hartford power station the Emmet plant, developing some 2400 horse-power, is accommodated within a space no greater than would be required for a 600 horse-power steam boiler. This comparison may perhaps be really less strikingly in favour of the binary-fluid turbine than it appears to be, because it may be influenced by the fact that the mercury boiler is oil fired and because of the purely arbitrary formula used in America for rating a boiler on a horse-power basis. Nevertheless, making all allowances for doubt and ambiguity, there is no reason for believing otherwise than that the adoption of the binary-fluid turbine would result in a very acceptable economy of space. Having said so much, it is greatly to be feared, in the light at any rate of our present knowledge, that we have come to an end of the catalogue of advantages of the system. On the contrary side, it is equally greatly to be feared, there are several weighty disadvantages, although being more of a practical or commercial nature than of a theoretical character, it may be held that time and perseverance will perhaps overcome them. On the score of prime cost and working charges other than those for fuel, information rests at present purely on guess work. Mr. Robinson's opinion that a mercury vapour-steam turbine plant would cost 25 per cent. more than a pure steam turbine equipment of the same power was not accepted by Mr. Kearton, who argued that the increase should not exceed a mere 4 per cent. or so. Nor, do we suppose, would the advocates of the system accept Mr. Robinson's estimate of the

increased working charges at 20 per cent. We have no means of forming a just estimate of the true position in these respects, but we feel that until it is definitely proved otherwise, Mr. Robinson must be regarded as being more nearly correct than Mr. Kearton, for the plant is admittedly complex in its arrangement and details, and would appear to call for the use of special materials and special methods in its construction. The highly poisonous nature of mercury vapour and the expense involved in acquiring the necessarily large amount of the fluid—estimated at £175,000 for a plant of 100,000-kilowatt capacity—are additional disadvantages of which much might be said, while the difficulty of obtaining constructional material that will withstand the high temperatures involved and the exceptional and unfamiliar action of mercury is a factor which, by itself, is, for the present at any rate, of grave moment.

In the midst of so much that is uncertain and so little that may be accepted as established, one fact emerges which appears to us to weigh heavily, even decisively, against the binary-fluid prime mover using mercury vapour as one of the working substances. Mr. Emmet is reported to have stated that per kilowatt capacity 7 lb. of mercury are required in his plant, but that he was hopeful of reducing that figure by some 50 per cent. How any such reduction is to be effected is not very obvious. Unless we can alter the latent heats of mercury vapour and steam—and man so far has discovered no possibility of ever being able to do so—we are definitely committed to using from eight to nine times as much mercury, by weight, as water in the system. This unfortunate result arises solely from the low value of the latent heat of mercury vapour. To reduce the quantity of mercury in the system without affecting the power output, it is thus alone open to us to increase the rapidity of the circulation. But while it is conceivable that the generation of the steam in the mercury condenser might be forced to a higher value than that at present in use, it would appear highly undesirable, and possibly even dangerous, to force the generation of vapour in the mercury boiler, for with forcing would come priming, and with any trace of "moisture" in the vapour, as Mr. Patchell has told us, the action of the fluid on common steel resembles that of a sand blast. Even, however, if we suppose that Mr. Emmet succeeds in reducing his mercury requirements to the great extent indicated, a station of 100,000 kilowatts capacity would still require 156 tons of the element, or, roughly, a twentieth of the world's average annual output. The advent of only one such station would, it is certain, completely upset the mercury market, and definitely render the establishment of a second more difficult and expensive. As a certain amount of annual replacement of mercury would be unavoidable, in spite of all precautions to prevent leakage and loss, we may reasonably conclude that all other disadvantages set aside, the problem of obtaining the necessary supplies of mercury must place a very precise and exacting limit upon the extent to which the binary-fluid prime mover, using mercury vapour as one of the working substances, can be developed and applied.

Locomotive Driving.

We have read with surprise Mr. Bromley's assertion before the National Wages Board last week that "if there was any single man on the railways of this country whose work had become more exacting, because of larger engines, greater speed and bigger loads, it was the locomotive man. His work had increased by at least 140 per cent." Such a statement, even in its general terms, will hardly bear close examination, and we are entirely at a loss to understand how such a precise figure as an increase of 140 per cent. was reached. If Mr. Bromley is correctly reported, his words mean that the strain and responsibility of driving locomotives is now nearly two and a-half times as great as it was a few years ago. It is so utterly impossible to find anything to warrant so great an estimate that we are led to believe that what Mr. Bromley actually meant was that the strain is 40 per cent. greater than it used to be. Since he based that figure upon increase of speed, increase of weight of trains, and increase of the power of engines, we may consider if there is any justification for measuring the strain upon drivers and firemen by such criteria.

In the first place, it must be remembered that whilst a few trains have been accelerated, average speeds remain very nearly as they have been any time during the past ten or fifteen years. Such trains as the Cornish Riviera Express, which Mr. Bromley used as an example, are exceptional, and they are driven by picked men in receipt of the highest wages. Mr. Bromley's statement that the engines hauling these trains consume about 50 lb. of coal per mile is, we believe, somewhat above the mark. The total consumption, London to Plymouth, is approximately 4 tons, equivalent to just about 40 lb. per mile. But 50 lb. per mile on stretches is not a new figure to firemen, and has never been regarded as imposing an excessive strain upon the men. It is only when it is combined with exceptionally high speed that it calls for a severe effort. Mr. Bromley shows that at 83 miles per hour 2075 shovelfuls of 2 lb. apiece must be thrown into the fire-box, whilst at 64 miles an hour 1600 similar shovelfuls must be moved. As a matter of fact, the highest average speed on the Great Western is only 61.8 miles per hour—Swindon–London—and the average speed on the Plymouth run is 54.8 miles per hour. Taking Mr. Bromley's figures, it is obvious that did a fireman use his shovel as suggested, he would be firing continuously at the rate of 2 lb. every two seconds or so, and the fire-door would never be shut. No man could do the work in that way without being exhausted in a few minutes, and, as a matter of fact, no fireman ever attempts it and no driver would allow it. We may notice in passing that since the average coal consumption is 40 lb. instead of 50 lb. per mile, Mr. Bromley's figures must be reduced by 20 per cent. for the whole run. In No. XV. of our series of articles on "Locomotive Footplate Experiences," Mr. Poultney recorded a trip from Paddington to Bristol. The weight of the train behind the draw-bar out of London was nearly 262 tons, and the average speed for the whole run was 53.2 miles per hour. On that occasion the firemen fired every two minutes, throwing in some five shovelfuls at a time, which is very different from firing 2 lb. at a time every two seconds. As a rough general rule for all trains, it may be said that firing takes place every two to three minutes, anything from five to ten shovelfuls being thrown in at a time, according to circumstances. But there are frequent pauses of more or less long duration, as when approaching stations, descending gradients or passing through tunnels, to say nothing of occasional signal checks. Hence it comes about that the work of firing is not nearly so continuous as Mr. Bromley's words might lead people to believe. No one would pretend that it is light work on a big engine with a heavy train behind it, but to-day it is not much harder than heretofore, and certainly does not put any undue strain on the men. It will, of course, not be forgotten that the introduction of superheating has brought about a reduction of, in round numbers, 10 to 15 per cent. in the amount of coal burned. It is partly for this reason that the large engines of to-day consume little more coal per mile than their saturated predecessors. Let us now consider the driver's duties on express trains. The amount of vigilance he is called upon to exercise is now no greater than it was ten to fifteen years ago; but the improvements in signalling have made it, if anything, less onerous than it was. It is true that heavier trains have to be hauled, and some of them at higher speeds, but the engines are always up to the duties assigned to them, and the actual art of driving becomes, if anything, easier, owing to various improvements in engine design. The cabs are now arranged, not only to give the enginemen complete protection from the weather, but in such a manner that all the crew's duties may be performed comfortably and without undue exertion. The drivers of Mr. Gresley's great new three-cylinder engines have commented on the facility with which those engines are handled. Furthermore, in the case of such crack trains as the Riviera expresses, the road is carefully "made," so that the driver has little or no anxieties about the positions of other trains. As far as the mere effect of speed is concerned, we imagine that it is negligible. It is highly improbable that a driver who takes his train a couple of hundred miles or so at an average speed of 60 miles per hour or thereabouts, feels any more strain from so doing than if he took it at 40 or 50 miles per hour. One other fact must be remembered. Railwaymen work, now, only eight hours a day, and the time that they are actually in charge of trains is in many cases a great deal less than that.

The arguments employed by Mr. Bromley have been used many times before. There is nothing new about them except the figures, and their bearing upon the rate of wages is probably but small. Payment in nearly all cases follows responsibilities rather than labour, and a better case could be made out by train men pointing to the fact that their responsibilities are greater than they were, because the value of the machines entrusted to their care and the value of the trains hauled are greater. That is an interesting aspect of the whole question of wages which we might develop, were it not better to leave such matters to the consideration of the National Wages Board, which has them now in hand. We have only touched upon Mr. Bromley's assertion because we have found that the public is rather impressed by his calculations, and it seems desirable to us to present them in their true light.

Joint Patentees.

Inventors rarely hold their patents by themselves to the end of the life of the rights. They usually either join others in the work leading to the invention, add them before or during the patent stage for reasons connected with finance, grant licences after the patent has been granted, or assign the entire rights to a second party who may either be a person or a company. In all such cases doubt as to what the inventor is entitled to do and to prevent others doing under the patent, and how persons who own part of the patent rights are affected is expressed.

In the case of a straightforward assignment of the whole interest little trouble is usually experienced, but a cause of contention arises when with the assignment of the rights of the patent there are included rights to future improvements. Should such improvements ultimately be made and become valuable decision has to be made whether the improvements are more closely related to the prior art or to the inventive territory protected by the patent. This is a difficult matter and a highly technical one, which it is sufficient here merely to indicate. A more common difficulty occurs in connection with patents taken out in the names of persons jointly or in the names of a person and a firm. It may arise whether both parties contributed to the formulation of the invention or whether one was added as a mere joint applicant for financial purposes. If a patent be granted to two parties the rights of the parties are clearly indicated in the present Patents Acts, where it is provided that if a patent be granted to two or more persons jointly they shall, unless otherwise specified, in the patent, be treated as joint tenants, but subject to any contracts to the contrary each of such persons shall be entitled to use the invention for his own profit without accounting to the others, but shall not be entitled to grant a licence without their consent, and if any such person dies his beneficial interest in the patent shall devolve on his personal representatives as part of his personal estate.

The matter is often not clearly understood, because in this respect the law of this country differs from the laws of certain other countries. Co-owners of a British patent are clearly not entitled each to consider that he owns a respective moiety of the rights. Being joint tenants they have what may be regarded as a joint right to possession, so that neither is able of himself to pass to others any part of the invention. Legally they are regarded as one entity and, therefore, indivisible. If the two together jointly grant a licence or make an assignment that is quite in order but an alleged licence purporting to be given by one of the parties to anyone else is without legal foundation. A licence does not transfer any rights of the patentee but is merely a permission to do what otherwise would be illegal. Clearly this permission could not be given by one person from a joint entity, so that the Act expressly states that a licence may not be granted by one party without the consent of the other.

It does not appear to have been fully decided whether one joint owner can maintain an action for infringement without joining those who hold jointly with him, but there seems some justification for such action.

Joint owners at any time may agree to sever their interests and, thereafter, such arrangements apply as are provided for by the deed covering the transaction.

In the case of joint owners, say, an inventor and a firm, in which the inventor is an employee of the firm, it may be that the inventor can hold no valid rights himself; they may all belong to the firm. This is a matter which has to be decided on the merits of each particular case. The invention of an employee is not necessarily the property of his employers. If the invention bears no substantial relationship to the work which the employee is paid to do, whether the invention be made in the employer's time or not, or by means of materials belonging to the employer, the rights in the invention would belong solely to the inventor. On the other hand, if a skilled person were employed, say for research purposes or for conducting particular work, any invention made as the direct result of such employment would be the property of the employer, although the patent would have to be applied for in the name of the actual inventor, whether the employing person or company were joined as a co-applicant or not. The rights in the patent when granted could then be transferred to the employer in an appropriate way.

We are informed that Viscount Long of Wraxall has accepted the Presidency of the forthcoming Empire Mining and Metallurgical Congress to be held at the British Empire Exhibition on June 3rd to 6th (inclusive), 1924, of which the Prince of Wales is hon. President. The following official personages have accepted invitations to become hon. Vice-presidents of the Congress:—The Secretary of State for the Colonies; the Secretary of State for India; the Secretary for Mines; the Prime Ministers of Canada, Australia, New Zealand and Newfoundland; the High Commissioners of the Dominions and British India, and the Lord Mayor of London. The Presidents of the seven convening bodies will act as Vice-presidents, and will preside over the sections with which they are concerned.

Institution of Mechanical Engineers.

BINARY FLUID TURBINES.

THE paper entitled "The Possibilities of Mercury as a Working Substance for Binary Fluid Turbines," which Mr. W. J. Kearton, of Liverpool University, presented before the Institution of Mechanical Engineers in London last Friday evening, was, as might be supposed, concerned almost entirely with theoretical considerations. Practical experience with binary fluid turbines is still very scanty. In fact, so far as we are aware, it is confined to the work done in the United States by Mr. W. L. R. Emmet, and concerning that work a good deal of secrecy has been preserved. We know that in 1914, when Mr. Emmet first described his ideas in public, he had been working upon them for some time, and that his apparatus had, apparently, then reached a workable stage. Subsequently, the General Electric Company of America constructed a mercury-vapour boiler to his design, an illustration and description of which was published in our issue of November 19th, 1920. In that article, which was based on an account in an American contemporary, it was stated that a mercury-vapour turbine had also been made and that, for a period during the summer of 1920, it had been operated under a load of about 1000 kilowatts. Mr. Emmet, at that date, claimed that in a good modern power station the adoption of his system would increase the capacity by 66 per cent. with an increase of only 15 per cent. in the fuel used, and added that the system was then being applied commercially. In the course of his paper, Mr. Kearton stated that a second mercury-vapour turbine had just recently been put into operation. This second turbine plant is, presumably, that inspected by Mr. Patchell during his recent visit to the United States, some details of the design and working of which he was enabled to give the meeting last Friday, and of which, by his courtesy, we reproduce photographs herewith and on page 560.

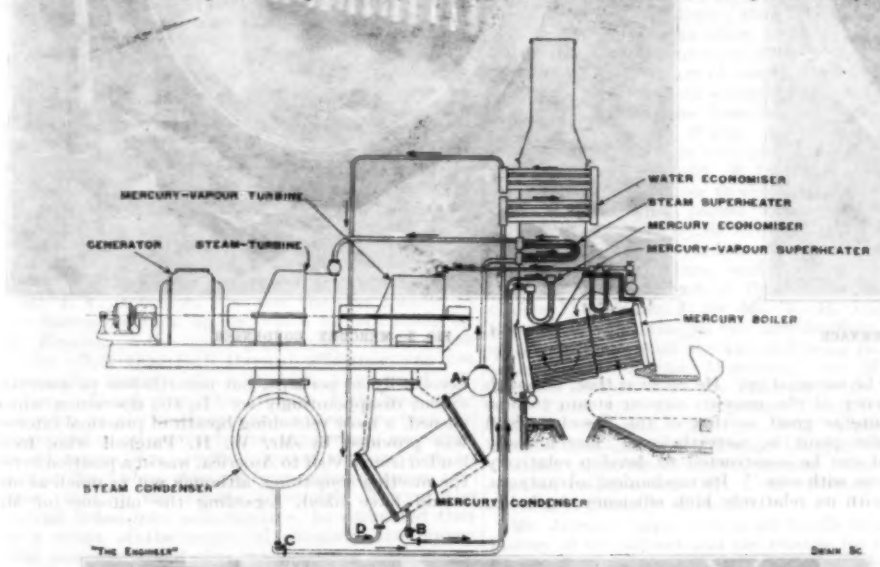


FIG. 1—DIAGRAM OF MERCURY VAPOUR STEAM TURBINE PLANT

As we have stated, Mr. Kearton's paper was devoted almost wholly to the theoretical side of the subject. He barely mentioned Mr. Emmet's work—incidentally, as we have indicated, he was in error in supposing that no information about it had been published in this country—described a suggested form of pipe joint designed to prevent the escape of the very poisonous mercury vapour, and briefly indicated, by means of a diagram, one arrangement of a combined mercury-vapour and steam turbine plant. With these exceptions, his paper may be described as dealing with the thermo-dynamics of the subject. A somewhat involved explanation of the gain sought by using the binary fluid principle was followed by an attempt to evaluate the relative economies of a pure steam turbine plant and one of the same output using steam and mercury vapour. Towards the end some attention was given to incidentals, such as the choice of steam pressure in a binary fluid turbine plant, and the flow of mercury vapour through nozzles, while in an appendix tables were given of the thermal properties of mercury vapour after the manner of the more familiar steam tables.

It will, perhaps, suit the practical tastes of our readers best if we begin our account of Mr. Kearton's paper and the discussion which it elicited, by referring to his diagram, reproduced herewith in Fig. 1, showing the arrangement of a mercury-vapour steam turbine plant. In this arrangement the mercury boiler alone is fired. The vapour generated, after being superheated, passes through a turbine specially designed for the exclusive use of the vapour, and thereafter flows into a condenser, whence it is returned by an extraction pump B through an economiser into the boiler. The exhaust from the steam turbine is delivered into a separate condenser, from which the liquid is drawn by the pump C and sent through an economiser inserted in the path of the hot flue gases coming from the mercury boiler furnace. The warmed liquid is next delivered at D to the mercury condenser, and is there evaporated by the heat liberated by the cooling and condensing mercury vapour, and in which it—the warmed liquid—plays the part of the circulating water for the mercury. The steam generated collects in a vessel A, and after being superheated is delivered to the steam turbine.

It is not to be supposed that the binary fluid principle is new, that Mr. Emmet is the pioneer of it, that mercury vapour is the only second fluid available, or that the turbine is the only form of prime mover to which the system can be applied. The binary fluid principle, as Mr. Kearton stated in his paper, was proposed by du Tremblay in, or about, the year 1850. In those days the reciprocating engine was alone in view, while the second fluid contemplated was the vapour derived from volatile liquids, such as ether, sulphur dioxide, or carbon bisulphide. For various reasons, chiefly because the reciprocating steam engine cannot utilise a high vacuum efficiently, the principle languished until the coming of the steam turbine, a form of prime mover adapted to use to advantage the highest possible vacuum, directed renewed attention to it. Incidentally, it may be remarked that the Still engine is a form of reciprocating prime mover based on the binary fluid principle. It may also be remarked that in the early days of the principle, it was intended that the steam should be the high temperature fluid, and the second vapour the low temperature one. To-day, both in the Still engine and in the Emmet turbine plant, the reverse course is followed, the second vapour being the high temperature fluid, its exhaust heat being used to generate steam as the low temperature vapour.

Since the thermal efficiency of an ideal heat engine operating between the absolute temperatures of T_1 and T_2 is, according to the Carnot cycle, expressed by $(T_1-T_2)/T_2$, it follows that to improve the thermal efficiency of an engine we may either lower the final temperature or increase the initial. For practical reasons, the latter alternative alone affords scope for any considerable development. To increase the initial temperature we may either resort to superheating or raising the pressure or adopt both. It can, however, readily be shown that if the limit to which we may raise the initial temperature is fixed—as it is in general by reason of practical considerations, such as the effect of high temperature upon the strength of materials—then the efficiency may be better improved by increasing the initial pressure than by raising the superheat. Thus, to quote an example given in Mr. Kearton's paper, let us suppose that the total steam temperature is fixed at 600 deg. Fah. If steam at 200 lb. pressure be used it could be superheated by 218 deg. Fah. The thermal efficiency—on the Rankine cycle—would be 32.85 per cent. If, however, we used steam at 500 lb. pressure we could still superheat it 131.4 deg. Fah. The efficiency would then be 36.8 per cent., or 12 per cent. more than before.

Progress towards the use of high-pressure steam has been and is being made. In Germany experiments have been made with reciprocating engines using steam at 900 lb. and a total steam temperature of 842 deg. Fah. It was found that while the high pressure cylinder showed a satisfactory efficiency, the low-pressure cylinder gave a relatively poor result, unless the steam supplied to it was re-superheated. With such re-superheating and with certain improvements in design it was estimated that a large engine using steam of the quality indicated should give an indicated thermal efficiency of nearly 32 per cent. In this country experiments on re-superheating in connection with turbines were carried out some years ago, but it was found that the efficiency of the principle was much less than in the case of reciprocating engines, and that the complexity involved in the pipe connections was such as to restrict its adoption except under special conditions.

In addition to improving the thermal efficiency, the use of high steam pressure has the advantage that the amount of condenser cooling surface is reduced, a reduction of 10 to 12 per cent., according to Mr. Kearton, attending an increase of the initial pressure from 200 to 590 lb. On the other hand, the higher the initial pressure the greater will be the density and, consequently, the losses arising in a turbine from windage, gland leakage, or tip-clearance leakage. Again, if the total steam temperature is fixed, the higher the pressure the less will be the initial superheat that may be given to the steam, and the sooner will it reach the saturation point

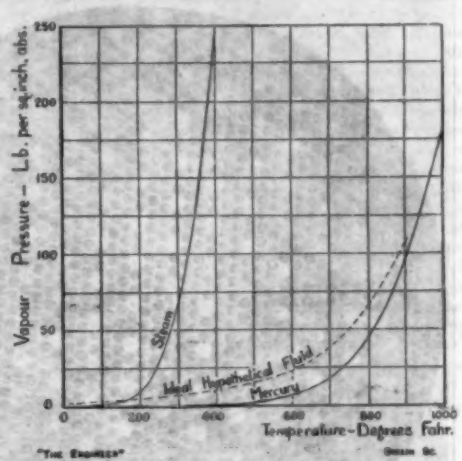


FIG. 2—VAPOUR PRESSURES OF WATER AND MERCURY

during its expansion, with the result that in the low-pressure stages the efficiency will suffer.

Grouping all the advantages and disadvantages attending the use of high-pressure steam, it may be said that steam falls short of being an ideal working fluid, because at the temperatures we desire to reach for the sake of improving the efficiency the pressures are too high. At the other end, its pressure is too low and its specific volume too great at temperatures corresponding to that of the circulating water, with the result that difficulty arises in providing the necessary area for the flow of the fluid in the last stages of a turbine. There is no fluid in existence which at high temperatures, say, roundabout 600 deg. Fah., has a low vapour pressure, and at the same time at low temperatures, say, 60 deg. Fah., has a relatively high pressure. In Fig. 2, taken from Mr. Kearton's paper, the vapour pressure of steam and mercury are set out against temperature, and are compared with those of an ideal hypothetical fluid, such as theory indicates to be desirable. It will be noted that the mercury curve is not very far below the ideal at high temperatures, but that even at 400 deg. Fah. its vapour pressure is exceedingly small. A few exact figures may be given. At 100 deg. Fah. mercury has a vapour pressure of 0.000094 lb. per square inch absolute as compared with 0.946 lb. for steam. At 400 deg. the vapour pressures are respectively 0.4 lb. and 247 lb., while at 600 deg. they are 6.625 and 1540 lb. Even at 800 deg. Fah. the vapour pressure of mercury is only just over 45 lb. and at 1000 deg. it is barely more than 180 lb.

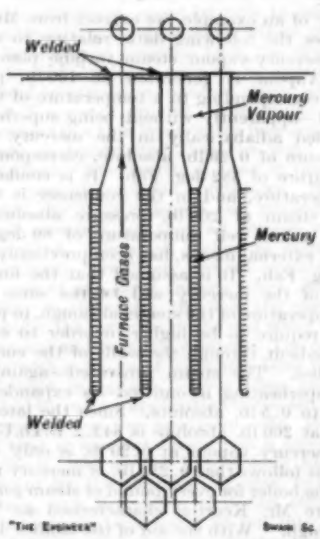


FIG. 3—TUBES IN EMMET MERCURY BOILER

It will thus be gathered that while mercury fulfils the requirement of providing a vapour having a low

pressure at high temperatures, steam is better than mercury vapour with regard to providing a relatively high pressure at low temperatures. The use is thus indicated of mercury vapour in a low pressure, high temperature turbine, combined with the use of steam in a high pressure, low temperature turbine. The binary fluid prime mover thus derives from the impossibility of obtaining a single fluid that possesses the desirable qualities over the whole working range, and the possibility of obtaining two fluids possessing the required characteristics over restricted portions of the range.

By way of an example, we extract from Mr. Kearton's paper the following data, relating to a hypothetical mercury-vapour steam turbine plant. The mercury vapour is generated at 100 lb. pressure absolute, corresponding to a temperature of 907 deg. Fah., and—apparently without being superheated—is expanded adiabatically in the mercury turbine to a pressure of 0.29 lb. absolute, corresponding to a temperature of 382 deg. Fah. It is condensed at this temperature, and in the condenser is used to generate steam at 200 lb. pressure absolute from water at a hot well temperature of 80 deg. Fah., which, by external means, has been previously heated to 382 deg. Fah. It is assumed that the final temperature of the mercury will be the same as the initial temperature of the steam, although, in practice, it would require to be higher in order to establish a heat gradient through the walls of the condenser-boiler tubes. The steam generated—again, apparently, superheating is omitted—is expanded adiabatically to 0.5 lb. absolute. Since the latent heat of steam at 200 lb. absolute is 843.2 B.Th.U., while that of mercury vapour at 0.29 lb. is only 129.582 B.Th.U., it follows that 9.284 lb. of mercury must be fed into the boiler for every pound of steam generated. This figure Mr. Kearton characterised as "unfortunately high." With the aid of the Mollier diagram, it can be shown that 1 lb. of steam, under the conditions given, would perform 367 B.Th.U.'s of work, while 9.284 lb. of mercury would give 482.3 B.Th.U.'s, so that per pound of steam generated the total work done would be 849.3 B.Th.U.'s. The steam consumption per shaft horse-power-hour would thus be 2.997 lb., and the corresponding mercury consumption 27.825 lb. Analysing the heat supplied, it is found that the thermal efficiency works out at 51.99 per cent.

If, in this example, the initial temperature of the mercury is made 1000 deg. Fah., instead of 907 deg., the efficiency, it is found, is increased to 55 per cent. Neither of these temperatures, it is safe to say, is practicable in the present state of engineering and metallurgical science, but if we assume with Mr. Kearton that 812 deg. Fah. is practicable—an assumption that many will doubt—the efficiency falls only to 50.5 per cent. Taking this figure, and assuming a boiler efficiency of 80 per cent., and a like efficiency for the turbine, the brake thermal efficiency works out at 32.3 per cent. Although this figure is less than those recorded for Diesel engines and the Still engine, it, nevertheless, compares very favourably with the 19 to 20 per cent. efficiency recorded for a turbine using steam by itself at a pressure of about 200 lb.

Mr. Kearton's conclusions, as a result of his analysis, may now be summed up. He believes that, although the efficiency of the mercury-vapour steam turbine is not quite as great as that of the Diesel or Still engine, the plant is, nevertheless, "mechanically ideal, and can be constructed to develop relatively high powers with ease." Its mechanical advantages, coupled with its relatively high efficiency, he holds, is, he believes, not beyond the bounds of possibility, although, naturally, such applications will not be made until after the system has got over its "teething troubles" on shore.

It will be admitted, we think, that Mr. Kearton's treatment of his subject was highly theoretical, necessarily so perhaps, but nevertheless to a certain extent disappointingly so. In the discussion which ensued, a most refreshing breath of practical interest was provided by Mr. W. H. Patchell who, fresh landed from a visit to America, was in a position to tell the meeting something, although not as much as one would have liked, regarding the outcome of Mr.

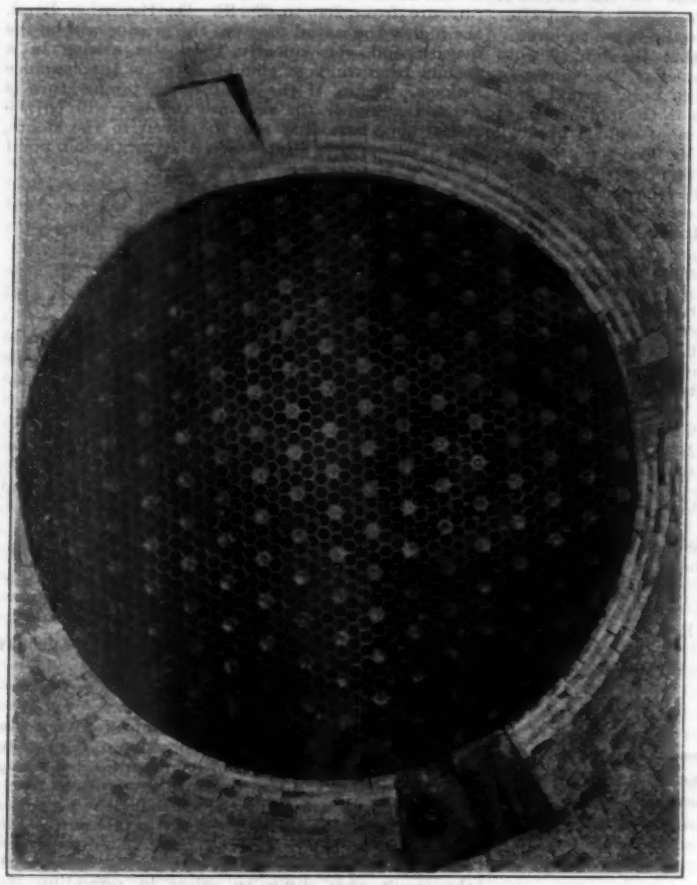


FIG. 4—UNDERSIDE OF EMMET MERCURY BOILER FROM FURNACE

FIG. 5—MERCURY CONDENSER

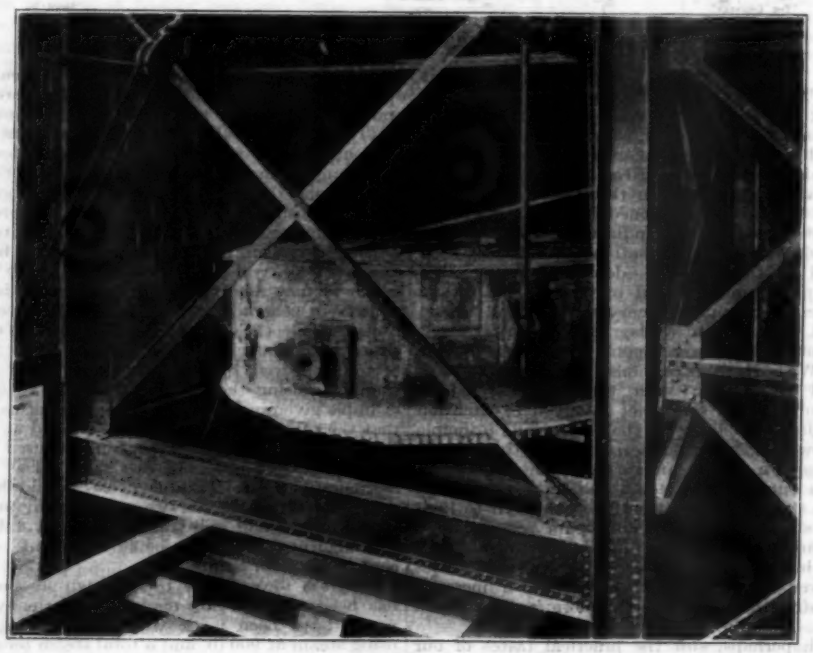


FIG. 6—MERCURY BOILER IN POSITION

"will probably make it the foremost prime mover for the generation of electric power on a large scale." He doubts whether it will ever be adopted for the propulsion of merchant ships, because simplicity and trustworthiness are factors of more importance in such a case than fuel consumption. Nevertheless, on trade routes on which coal is cheaper than oil, the adoption of the mercury-vapour steam turbine

Emmet's work. The photographs reproduced herewith and on page 563, were brought back by Mr. Patchell from America, and represent the Emmet plant as installed at the station of the Hartford Electric Light Company at Hartford, Conn., to the president of which company—Mr. Samuel Ferguson—Mr. Patchell paid a high tribute for his desire to encourage development and progress. The Hartford

plant drives an 1800-kilowatt alternator, and according to a diagram of it thrown on the screen, would appear to follow in its arrangement closely, but not quite completely, the plan indicated by Mr. Kearton in Fig. 1. The oil-fired mercury boiler, Mr. Patchell remarked, worked at a pressure of 35 lb., the vapour being at a temperature of about 850 deg. Fah.—800 deg., plus 50 deg., of superheat. The exhaust temperature of the mercury turbine was 432 deg. Fah., the vacuum being 28½in. The steam boiler worked at 200 lb., and the steam was superheated by 80 to 100 deg. of added temperature. The whole plant, turbine generator, boiler and condenser, Mr. Patchell remarked, occupied a space not greater than would accommodate one 600 horse-power boiler, that was to say, a boiler with 6000 square feet of heating surface. He stated that great difficulty had been found at first in obtaining castings which were tight to mercury. At a temperature of 850 deg. Fah., common steel was next to useless for making the parts of the plant in contact with the mercury, for it was found that if the mercury vapour contained any trace of moisture—that was, of course, mercury moisture—the steel was cut just as if it had been subjected to a sand blast. He expressed considerable doubt regarding the practical future of the mercury vapour steam turbine, particularly on the score of the difficulty experienced in obtaining materials that would withstand the high temperatures used and the penetrating and amalgamating propensities of mercury. In conclusion, he stated that the high steam pressures mentioned by Mr. Kearton as having been tried in Germany had already been exceeded, that boilers for 800 lb. were now on order in this country, and that others using 1200 lb. pressure would shortly be in service in America. On the subject of welded joints, which the author had raised by the description of a form of joint designed to avoid the necessity of welding and yet to possess mercury vapour tightness, Mr. Patchell said that it was really unnecessary to avoid welding, for a welded joint could readily be broken at any time by means of an acetylene jet.

Mr. Patchell's photographs require little explanation beyond that given in the titles, except perhaps that reproduced in Fig. 4, which, it may be remarked, is an interior view of the mercury boiler as seen looking vertically upwards from the furnace. A diagram of the tube arrangement adopted is given in Fig. 3. The tubes, it will be gathered, are hexagonal in section at the lower end, where they are welded together in the form of a honeycomb, while at the upper end they are reduced to a circular section.

Mr. I. V. Robinson, who was the first speaker in the discussion, took as his text a remark made by Mr. Kearton in the opening paragraph of his paper to the effect that high thermal efficiency was not necessarily synonymous with high commercial efficiency. Developing this theme with particular reference to the mercury-vapour steam turbine, he attempted to estimate what saving per unit generated would accrue if a 10,000-kilowatt station, such as that at Blackburn, changed from ordinary steam turbine plant to the binary principle. Taking the no-load losses into consideration, he estimated that as a result of the improved efficiency the binary fluid principle would save three-eighths of the steam turbine fuel. Setting the saving thus represented against an estimated 20 per cent. increase in other works' costs, and an increase in capital charges arising from the binary plant being an assumed 25 per cent. more expensive than an ordinary steam turbine equipment, he came to the conclusion that the binary principle would yield a net saving of 0.05d. per unit generated. Should coal rise to twice its present price—an almost unthinkable proposition—the net saving would still only amount to 0.25d. per unit even if no allowance were made for the fact that with coal doubled in cost the plant would be more expensive to purchase and install. The proposition could not be regarded as attractive, for no engineer could recommend such a wholesale change for the sake of saving one-twentieth of a penny per unit. In a concrete instance, it might be noted, a London station—that at Stepney—saved a net ¼d. per unit by the installation of a new type of steam turbine.

Others taking part in the discussion were Mr. H. M. Martin, Mr. Max Konig and Mr. Selvey. Mr. Martin criticised the author's procedure in basing his comparison of the mercury-vapour turbine and the steam turbine on the Rankine cycle, arguing that in the superheated field such a comparison did less than justice to mercury vapour, while in the saturated field, he was inclined to suspect, it over-estimated the relative advantage of that vapour as compared with steam. Mr. Konig detailed the results of some calculations which he himself had carried out in connection with the binary fluid principle, and expressed the opinion that the figures arrived at in America were too optimistic. He had great hesitation in accepting Mr. Kearton's view that the mechanical advantages of the mercury-vapour turbine, combined with its high thermal efficiency, would probably make it the foremost prime mover for the generation of electric power on a large scale. Mr. Selvey said that 750 deg. Fah. was about the highest temperature to which the makers of steam pipes and fittings would care to subject their products. The effects of such a temperature were becoming known, and were not such as to encourage engineers to go much farther.

In his reply to the discussion, Mr. Kearton had time only to deal partially with Mr. Robinson's remarks. He endeavoured to show that that gentleman's assumption that the mercury-vapour steam turbine plant would cost 25 per cent. more than a pure steam turbine installation was wrong, and adduced figures which indicated that the prime cost of the binary plant for a 100,000-kilowatt station would be £29 per kilowatt capacity, as compared with £28.1 for a pure steam plant.

Public Works & Transport Congress.

No. I.

The Public Works, Roads and Transport Congress and Exhibition were opened at the Agricultural Hall, Islington, yesterday, the 22nd inst., and will remain open till Thursday of next week. We shall postpone our report upon the Exhibition till our next week's issue, and shall confine ourselves in the present instance to a reference to the first day's proceedings at the Congress. It may here be explained that the Congress is being held under the joint auspices of a number of separate bodies, and that on its organising committee there are representatives from:—The County Surveyors' Society; the Association of Road Surveyors in Scotland; the Incorporated Municipal Electrical Association; the County Councils' Association; the Association of Municipal Corporations; the British Waterworks Association; the Scottish District of Municipal and County Engineers; the Urban District Councils' Association; the Rural District Councils' Association; the Institution of Gas Engineers; the Institution of Municipal and County Engineers; the Ministry of Health; the Institute of Cleansing Superintendents; the County Land Agents' Association; the Association of County Councils in Scotland; the Convention of Royal Burghs; and the Association of Managers of Sewage Disposal Works.

The Conferences held yesterday had both of them been arranged by the Association of Managers of Sewage Disposal Works. At the morning Conference, which was held under the chairmanship of Mr. Joseph Garfield, M. Inst. C.E., who is the Sewage Works Engineer to the Corporation of Bradford, the following papers were considered:—(*a*) "Rivers Pollution," by Mr. C. Jepson, who is Resident Chemist at the Davyhulme Sewage Works of the Manchester Corporation, and (*b*) "Sewage Works Analysis and Standards of Purification: a Plea for Greater Uniformity," by Mr. J. H. Garner, the Sewage Works Manager at Huddersfield. At the afternoon Conference the two following papers were taken:—(*d*) "Sludge Digestion," by Mr. J. D. Watson, M. Inst. C.E., the Engineer to the Birmingham Tame and Rea Drainage Board"; and (*e*) "Sludge Disposal," by Mr. John Haworth, the General Manager of the Sewage Disposal Works and Chemist to the Sheffield Corporation. The chairman on this occasion was Mr. I. G. Gibbon, Assistant Secretary, Ministry of Health.

Mr. Jepson's paper first of all briefly reviewed the history of the subject and the reasons for the failure of the Act of 1876. The author then went on to remark that failure to make proper use of purification plant was probably one of the most frequent reasons for pollution of streams. The risk of pollution was, he said, lessened when the trade waste was passed into the sewer, for in that case one plant under constant supervision was substituted for a number of small plants at separate mills. It was suggested that, in addition to the recommendations made by the Royal Commission on Sewage Disposal, provision should be made to guard against inadequate or wilful neglect of preliminary purification plants by the imposition of suitable penalties. Local Authorities should, it was suggested, be given power entirely to prohibit, without recourse to complicated legal machinery, the discharge to the sewers of any waste material which would:—

(1) Give rise either alone or in combination with the sewage itself, to conditions dangerous to the life or health of workmen engaged in the sewer;

(2) So alter the character of the sewage as to disorganise any practicable type of sewage purification plant;

(3) Create serious nuisance.

The creation under the control of the central authority of a research laboratory to undertake work of importance to the whole community was, it was urged, also worthy of consideration.

Mr. Garner, in his paper, after referring to the systems of analysis in vogue and drawing attention to divergencies between the various ways of expressing results employed by different investigators, especially as regards nitrogen, asserted that there was urgent necessity for an inquiry into the methods of analysis in general use, with a view to the adoption of standard methods and procedure and a uniform system of recording analytical results. It was suggested that the publication of standard methods of analysis upon the lines adopted by the American Public Health Association would prove of great value to all employed in connection with sewage disposal and to chemists generally. Co-operation with the object of evolving a universally recognised system of recording results of analysis and of standardising analytical methods and procedure seemed specially desirable at the present time when, both here and abroad, analytical records with regard to the activated sludge process were rapidly accumulating.

In Mr. Watson's paper was given a description of the method of sludge disposal practised at the works of the Birmingham Tame and Rea District Drainage Board. There the sludge is transferred from a given sedimentation tank into the selected digestion tanks—generally five or six in number—by pumps, and, simultaneously, some of the ripest of the available sludge is pumped from a digestion tank into the same delivery main in the proportion of 1 to 4, thus inoculating at the earliest moment the fresh sludge with fermentative organisms. It was observed quite early that inoculating raw with ripe sludge had an excellent effect upon the speeding up process. In addition, steam, when it is available, and in cold weather, is injected into the delivery main to encourage temperature conditions most favourable to fermentations. The total tank capacity provided is 350,000 cubic yards, which represents approximately 6½ months' production of wet sludge, and, under working conditions, is equal to a digestion period of five months. Of the total capacity 190,000 cubic yards are used for primary digestion, and 160,000 cubic yards for secondary digestion. Digestion in two stages was adopted in 1912, as it was found that vigorous fermentation was encouraged and tank space saved by pumping from one tank to another. Indeed, the second pumping was more economical than building, but even now, with a tank capacity equal to five months storage, it is still necessary to pump twice.

The general analysis of the sludge was given as being as follows:—

	1915-18 inclusive. Per cent.	1919-22 inclusive. Per cent.
Water	92.5	92.0
Dry solid matter	7.5	8.0

Specific gravity—	Per cent.
Wet sludge	1.0256
Dry solid matter	1.50

And the average analysis of the solid matter as:—

	Per cent.
Matter volatile at red heat	58.5
Matter non-volatile	41.5
Total nitrogen	2.71

The rotted sludge, or residuum of the fermentation process, is pumped direct to the drying beds, which consist of ¼ acre plots of engine ashes, the total area being about 60 acres. All the plots are under-drained with 4in. agricultural pipes laid in herring-bone fashion toward a main leader which conveys the drainage to a well, whence it is pumped up to a percolation filter.

Each drying bed is formed by earthen banks about 2ft. high, and the sludge is deposited to a thickness of 18in. It dries down to about 6in. or 7in. The time required for drying varies with the weather. In dry weather it quickly cracks and admits air, but in our climate it would be rash to assume that it is possible to dry more than two fillings per annum. When the sludge is removed from the drying beds, it is delivered by light railway to contractors for storage and treatment in immense sheds, which stand on about 7 acres of ground. The sludge is broken up and spread in a thin layer on the floors of the sheds, which are so constructed that the wind can blow through them. The length of time it takes to dry depends upon atmospheric conditions. When it is sufficiently dry it is collected and ground into fine meal and screened, so that all foreign substances are eliminated. The meal makes an excellent base for a fertiliser. The finely ground condition of the meal is one of the chief factors which influence its availability to the crop; the finer the particles, the more rapidly the agencies in the soil effect the necessary chemical and bacterial changes. The contractors fortify it with sulphate of ammonia, bone phosphates and sulphate of potash. It is then bagged and despatched by rail for application to the land.

Commenting on the treatment, Mr. Watson remarked that it was put forward as a complete process in itself, just as the Imhoff tank process was put forward by the German engineer, but without, in its case, any suggestion that the effluent from the sedimentation tank could be put into a stream. It was not, he said, by any means the cheapest method of treatment, but it effectually converted an exceedingly offensive colloidal mass of sewage into a dry substance, which might be kept in one's office for years without giving off more odour than would garden soil under similar circumstances. It eliminated grease, it conserved the nitrogen, and the product might, on occasion, be used as fuel. The present-day cost, including working expenses and interest on capital, amounted to 9.6d. per cubic yard of wet sludge of an average water content of 92 per cent.

Mr. Haworth, in his paper on "Sludge Disposal," remarked that it had been asserted that the more recent developments in sewage disposal—such as the bio-aeration and activated sludge methods—had increased the difficulties of de-watering, since the sludges produced by those processes had a higher water content than sludge produced by earlier processes, and were more troublesome to deal with. In his opinion, that view had been much exaggerated,

and was not the result of actual experience of those sludges. The sludge problem was no new thing, and the economical solution of the difficulties attendant on it was nearer than it had ever been.

Various experiments in connection with sludge disposal were then reviewed. First of all, it was explained that sludge from the Dortmund tanks of an aeration plant had been dried on specially prepared ash beds, which consisted of a thickness of about 18in. to 24in. of graded clinker with good drainage. The top layer was of fine ash and about 4in. thick. Wet sludge, containing from 98.5 to 99.5 per cent. of water, had been applied in varying depths, and observations made of the period required to obtain a product which could be manipulated. When applied in depths of from 18in. to 24in., a long period was required to obtain a satisfactory result, but a depth of about 6in. of wet sludge was found to dry to a cake which could be handled in 18 hours, or less. If left for a few days in dry weather, the cake dried hard and cracked, and could be raked off. Six inches of wet sludge could be run on to the bed, allowed to stand from 18 to 24 hours, and the cake could then be removed by shovels. The filter was then raked over and allowed to dry for 24 hours, when it was again ready for a further dose of sludge.

Experiments had also been made in discharging the sludge on to a band of papermakers' gauze travelling over a vacuum box at a slow speed. With certain sludges a satisfactory de-watering effect had been obtained, the water content being reduced from 99 or 99.5 per cent. to from 72 to 75 per cent. At times, however, satisfactory cake could not be obtained owing to some variation in the physical character of the sludge. Oliver filters had also been tried, and good cake, containing from 75 to 80 per cent. of moisture, could be obtained with certain sludges, but, with no apparent change in conditions, the sludge, at times, would not give satisfactory cake, but clogged at filter cloth or gauze. It was found, however, that with certain of these sludges the addition of a small proportion of ordinary sedimentation land sludge containing a high mineral content would enable satisfactory cake to be produced. Experiments made with the addition of acid had not been satisfactory.

Experiments made with a 36in. Sturgeon centrifuge had shown that a reduction of water content from 99 or 99.5 per cent. to an average of 91 per cent. could be obtained, but the action appeared to be selective, and the lighter solids were not extracted from the sludge. The treatment resulted in a considerable decrease in bulk, but produced only a semi-liquid mud. Mention was also made of experiments in which flotation processes with air or other gases, such as are used in the separation of mineral ores, were employed. Rapid separations of a large quantity of water could be obtained.

Summing up the whole question, Mr. Haworth said that, while there was little doubt that further experiment would result in more rapid and less cumbersome methods of de-watering sludges, the drying of sludge on suitably prepared ash or sand filters appeared to be the most practicable and economical method on a large scale in existence at the present moment.

PADDY HUSKS FOR BOILER FUEL.

Some interesting information concerning the use of paddy husks for boiler fuel are given in the seventeenth Annual Report of the Bengal Smoke Nuisances Commission for the year 1922, which has just reached us. It appears that, a couple of years or so ago, paddy husks, which had, up to that time, been useless and difficult to get rid of, had, owing to economic circumstances, to be used as fuel in place of coal in the boiler furnaces of rice mills in India. There was nothing in the actual burning of the husks, but unless means could be provided for stopping the discharge of clouds of light charred husk from the chimneys, the surrounding districts would have been ruined for residential purposes. The Commissioners were, therefore, in a difficult position, as the penalties provided in the Act, under which they operate, were not sufficient to prevent the use of the husk. They decided, however, to permit its use provided that the public interests were safeguarded as far as practicable.

The paddy husk produced in the mills is difficult to deal with, as, in the process of milling, the husk is broken up and has a large proportion of fine powder. The joint endeavours of the owners and the Smoke Nuisances Commission Department produced an apparatus, which, in the latest and improved types, works satisfactorily. About half the rice mills had, at the date of the report, been provided with this apparatus, and the Commissioners, who are devoting careful attention to this question, are using every endeavour to induce the remaining owners to install it in their mills. The local resources were insufficient to supply in time all the furnace requirements, particularly in some of the accessories without which the results are adversely affected. Rice milling being a seasonal trade, some of the older types of furnaces were permitted to work for the season covered by the report, and the Commissioners express the hope that matters would have improved at the stoppage preceding the next season.

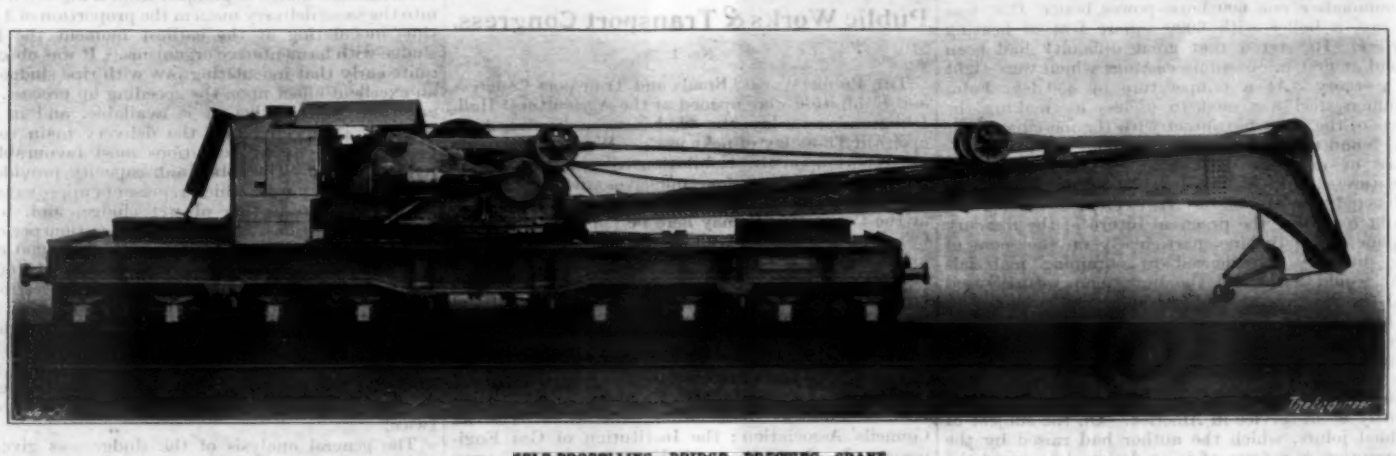
In the controlled area, forty mills had been fitted with paddy husk arrangements, and outside the area ten mills had been so fitted. The general results showed that the smoke from paddy husk will be very much less and the outturn from the boilers much more than from coal burners.

The matter was primarily taken up to protect the public from the smoke nuisance, but it is pointed out that, apart from this, it effects far-reaching economic results. Assuming that all the rice mills use paddy husk—which is a likely prospect—there should, amongst other advantages, be an annual saving of about 100,000 tons of coal, representing about 15 lakhs of rupees. The public, which uses machine-cleaned rice, ultimately gets the benefit of the reduced cost of rice, and in a family of ten members the annual rice bill should be reduced by about 4 rupees per annum.

Another discovery of manganese is reported from the Southern Transvaal, near the banks of the Vaal River.

Large Bridge-erecting Cranes for India.

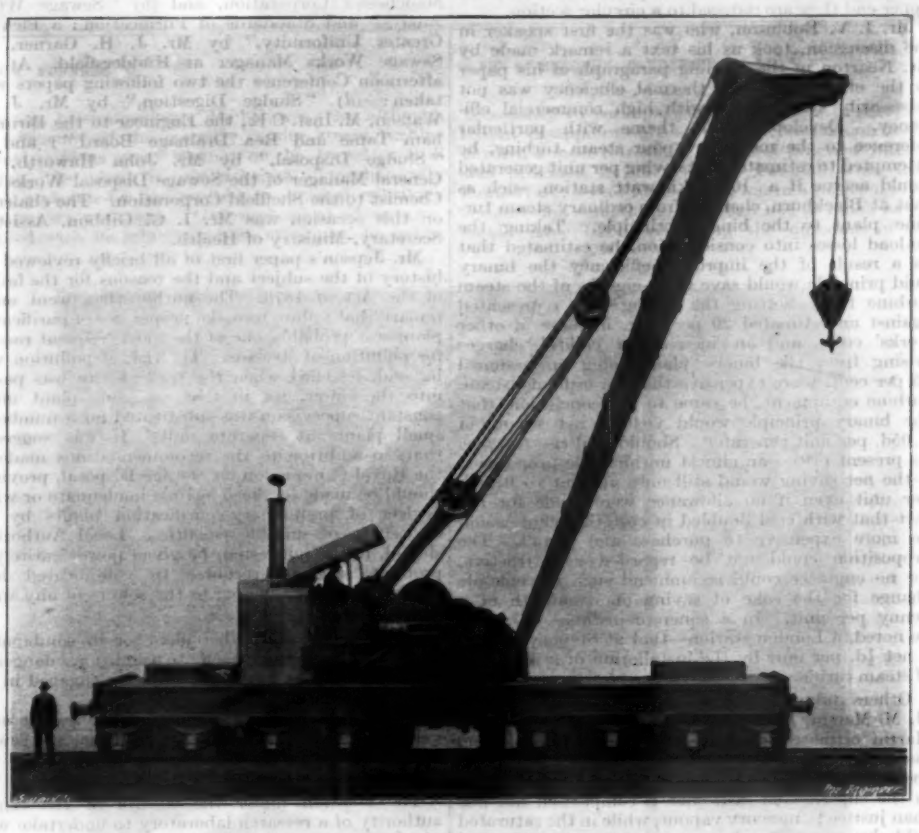
At the Waterside Ironworks of Ransomes and Rapier, Limited, on Friday last, we witnessed the trials under steam of one of two special bridge-erecting cranes which the company has built to the order of the Indian State Railways. The crane which we saw—and which is shown by the illustrations reproduced herewith—is of peculiar interest on account of the character of the work upon which it will be engaged, and it further merits attention because it is claimed to be the largest and most powerful British crane yet built to operate under similar conditions.



SELF-PROPELLING BRIDGE ERECTING CRANE

It will be used on the North-Western Railway of India for the purpose of reconstructing and strengthening a number of bridges on that system, and inasmuch as the crane, as well as performing its heavy duty, has to travel on the existing track and conform to the loading gauge of the line, the problem presented in designing it was of a very special nature. In getting out the details of the crane the builders worked to the specification of the consulting engineers to the railway, Messrs. Rendel, Palmer and Tritton, of Westminster.

When complete and in working order, the total weight of the crane is 136 tons, and the design is such that with the jib lowered upon a match truck for running in a train,



25 TON STEAM BRIDGE ERECTING CRANE

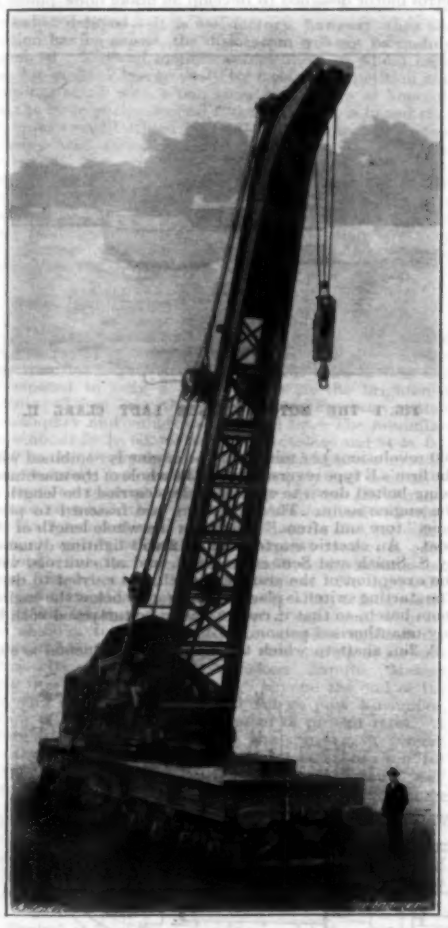
the load per axle does not exceed 19 tons static, while working with a load of 20 tons at 25ft. radius, with the jib at right angles to the track, no wheel load will exceed 15 tons static. The bending moments and shearing forces which will be imposed on a bridge by these loadings, even after they have been increased by 10 per cent. to allow for impact, are, we understand, well within the loads allowed by the railway for any length of cross girder stringer or main girder up to a span of 100ft. In addition to the above-mentioned duty of 20 tons at 25ft. radius unpropped, the crane will also travel with a 12-ton load with the jib parallel to the track and the load at a radius of 43ft. 3in., and when propped it will lift and slew in a complete circle a load of 25 tons suspended at a radius of 28ft.

The top part of the crane follows generally the firm's

usual design for permanent way cranes of the breakdown type, and the boiler and gearing are placed centrally on the carriage, so that a 12-ton bridge span may be lifted into position over either end of the crane. The height of the crane was determined by the loading gauge, which imposes a maximum of 13ft. 6in. over the rail level top. The width of the running gauge is 5ft. 6in. It will be noted that the crane carriage is carried on eight axles, each pair being bogied. The total length over the buffers is 50ft. 9½in. and the total length over headstocks 47ft. 7in., while the total wheel base is 44ft. 2in. Special features of interest are presented by the arrangement of the bogies, which has been designed so that the load is equally distributed over the whole wheel base, whether the crane is running in a train on the existing track or working on a contractor's track in the vicinity of the bridges it is proposed to strengthen. The drive is transmitted through both axles of each outer bogie, while the two inner bogies are fitted with complete vacuum brakes and hand brakes to work in conjunction with the vacuum brakes. Both adjacent pairs of bogies are articulated in a vertical plane, while each bogie is further capable of swivelling in a vertical and horizontal plane, and is also provided with a limited amount of lateral movement across the track, in order to assist in negotiating curves, which may be as sharp as of 500ft. radius. A compensating beam connecting the two bogies at each end of the carriage allows them to move in a horizontal plane, so that the carriage itself is kept as nearly as possible to the track centre. In order to transmit the drive to the two outer bogies and make due allowance for all possible rocking and swivelling movements, a shaft with a double universal joint is employed, one of the joints having a sliding motion. This shaft conveys power to a bevel drive at the centre of each outer bogie, from which the motion is transmitted to the driving axles by heavy cut gearing.

Here we may refer to the mechanically controlled props which slide on rollers and are hand worked by a neat rack-and-pinion arrangement. The propping base is made to be adjustable between 10ft. 3in. and 16ft., and the propping girders and their screw jacks have been so designed that if necessary the booms of the bridge may be used as a propping base.

Although primarily designed for bridge erecting, the

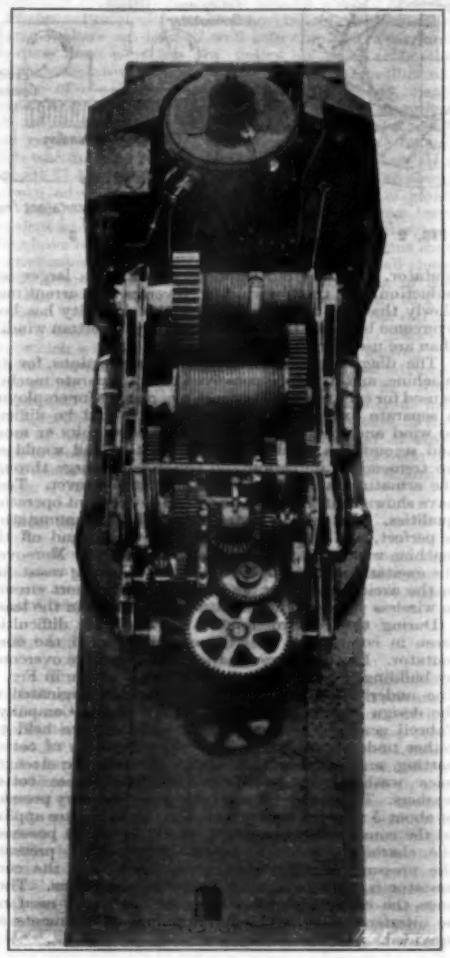


CRANE WITH JIB FULLY RAISED

crane may be required in emergency cases to be used for breakdown work. This eventuality has not been overlooked, and buffing and draw gear are provided, with proper springing and axle boxes, which, as previously mentioned, render the crane suitable for high-speed running in a train. It may be stated that when on the minimum curve the crane lies in the running gauge.

Space limitations have necessitated a somewhat squat boiler, which has a diameter of 4ft. 6in. and a height of 6ft. 3in. It is of the Spencer-Hopwood water-tube type, and is designed for coal firing and for a working pressure of 100 lb. per square inch. The usual boiler mountings are fitted, and both feed pump and injector are provided. The engine has two cylinders, each with a diameter of 9½in. and a stroke of 14in., Stephenson's link reversing motion being employed. The various motions comprise hoisting, slewing, derricking and travelling, and the slewing gear is driven through double friction cones, while all the other motions are furnished with dog clutches. These motions are controlled by a series of levers placed immediately in front of the driver and in a position commanding an excellent view of the load in all positions. Change gears are fitted so as to give two speeds for both hoisting and travelling. A slow travelling speed of 50ft. per minute is used for "inching" when picking up rivet or bolt holes in the girder. The slewing motion may be operated in either direction concurrently with any other motion, and a slewing brake is fitted. Four-inch circular derrick and hoisting ropes are fitted, and machine-cut gears of massive design are provided throughout. As shown in the illustrations, the crane is completely self-contained, with its own props, and the design is such that no extra or adjustable counterweight is required for any of the working conditions.

Among the tests under steam, which were performed on Friday last, in the presence of several of the leading railway engineers, were the following:—A test load of 31¼ tons, or 25 per cent. in excess of the working load of 25 tons with props, was lifted and slewed at a 28ft. radius,



VIEW OF CRANE OPERATING GEAR

after which the load was let down with the engine in gear. It was then raised and again lowered in a series of steady steps on the brake alone. The test load was then derricked, and the props removed from the crane, after which the normal 20-ton working load was slewed at a 20ft. radius. Travelling across the road with a 21¼-ton load at the same radius was then shown, as well as travelling and slewing together. The stability test consisted of the lifting of a load 37½ per cent. in excess of the working load, namely, 27½ tons, which was raised and slewed. Finally, a 12-ton load was dealt with at a radius of 47ft. 3in. with the jib parallel to the track, this being the most severe duty the jib has to undertake. All the trials were carried out satisfactorily and most expeditiously.

THE "BEAMA" ANNUAL DINNER.

On Thursday evening, November 15th, the Prince of Wales was the chief guest at the annual dinner of the British Electrical and Allied Manufacturers' Association, held at the Connaught Rooms. Many distinguished men were present, and Lord Derby, the President of the Association, occupied the chair.

The Prince, responding to the toast proposed by the chairman, said that he wished to take the opportunity of congratulating the "Beama" and of thanking its members for the big part they were taking in the organisation of the British Empire Exhibition. He could, perhaps, take it that he was not expected to speak as an electrical expert, and he would, perhaps, be forgiven if he made no reference to ohms and ampères, and if he confined his remarks to generalisations. In too many cases we were responsible for the discoveries, and foreign countries reaped the benefit of the exploitation of them. But he thought it could be claimed that we changed all that during the war, when British energy and enterprise brought the Empire into the front place as regards electrical manufacture. We were greatly indebted to the scientists, the manufacturers and the workmen who tackled the problems with which they were faced in 1914—problems which they not only faced, but surmounted successfully. He thought that the nation would take the Great War as a lesson and firmly make up its mind never again to fall back in the matter of electrical development. To keep our Imperial position it was essential to maintain a lead in electrical engineering, a lead similar to that which we undoubtedly held in the development of steam. If our thoughts had to be kept within the limits of this Kingdom, we might have to face the rather uncomfortable conclusion that our material resources, while great for the era of steam, were not so great for the era of electricity.

In water power, we had not the same potentialities as other countries, but if we extended our field, as we had the right—and, in fact, as it was our duty—to extend it, to the Empire as a whole, we found that overseas there were enormous resources in water power. In the great Dominion of Canada, electrical energy had been greatly developed. In fact, the possibilities of its extension were almost without limit, and in another part of the Empire, in far-away Tasmania, excellent beginnings had been made to utilise the water power of the lakes for the generation of electrical power. He was sure that South Africa and New Zealand would not be backward in developing their resources in that direction. It seemed clear that, if Great Britain continued to show the same energy and resource which had been shown in the past by scientific manufacturers and the workers in the industry, and gave the world the lead in new inventions and the practical application of the best of their machinery, the Empire would lead the world in the age of electricity as it had done in the age of steam.

TIMBER IN EASTERN ASIA.

In order to develop the timber industry in the Ussuri country, it would be necessary, according to some notes on the subject contributed to the *Far Eastern Review* by Mr. Ivan Booshkoff, to construct about 150 to 200 versts of side lines at the railway stations Ussuri, Iman, Bikin and Hor. Then the rivers should be cleaned in order to enable the floating of timber in spring. It would be further necessary to erect well-equipped sawmills and three-ply wood factories in places best suited for the purpose. Great advantages are offered, he says, by the village Rakitnee situated on the river Vak. It would be necessary to construct a line about 50 versts long connecting that village with the station Iman. The line would cross a plain, and no tunnels and bridges would be required. Another place is the confluence of the rivers Daubikhe and Ulakhe, which could be reached by extending the Sviagin line some 30 versts. It would also be advisable to construct two lines of an aggregate length of 100 versts from Bikin and Hor, reaching right into the heart of the forests (1 verst = about ⅔ mile).

Simultaneously with sawmills there should also be constructed various plants for the extraction of by-products from timber—paper mills, wood-pulp mills, and others. Well-equipped mills, with railways, rafting rivers, and low tariff, will appreciably lower the price of timber, and it would find a ready sale on foreign markets. It is only necessary to adapt the production to the requirements of those markets. The enormous reserves of high-grade timber, the close proximity of consuming markets requiring timber in large quantities, creates especially favourable conditions for a development of that industry, and facilitates competition with Oregon pine, which is more expensive than cedar.

Apart from markets adjoining the maritime province Ussuri timber could enjoy a great and steady demand in more distant countries of the Pacific, as in the instance of Australia, which requires about 10 million cubic feet of timber for cases, this figure showing a tendency to grow. Here, also, Ussuri timber has the possibility of competing with Oregon pine.

Naturally, the organisation of the timber industry in the Ussuri country will only be made possible with the assistance of foreign capital, since the Russians have none. There is but little doubt that foreign firms interested in that industry will be able to take advantage of the situation and begin the exploitation of the enormous reserves of timber, provided, naturally, that conditions are created guaranteeing a possibility of private enterprise and of a sound organisation of the enterprise.

LAUNCHES AND TRIAL TRIPS.

Invergarry, "N" standard vessel; built by Harland and Wolff, Limited; to the order of the British Mexican Petroleum Company, Limited; dimensions, 428ft. by 55ft. 5in. by 38ft.; 6900 gross tonnage. Engines, triple-expansion, 27in., 44in. by 73in., with 48in. stroke; constructed by the builders; launch, November 8th.

CONTRACTS.

We understand that the Clyde Crane and Engineering Company, Limited, has secured the contract for the crane equipment in connection with F. Braby and Co., Limited's, mill extension.

Association of Consulting Engineers: Annual Dinner.—The annual dinner of the Association of Consulting Engineers, was held at the St. Stephen's Club, Westminster, on the evening of Wednesday, the 21st inst., and, as have been all those which have preceded it, it was a great success. There is an "atmosphere" pervading these annual gatherings which is not experienced at the large majority of other similar meetings which it is our good fortune to attend. Everyone seems to know everyone else, and there is a delightful sense of good fellowship and camaraderie among the members and guests which makes the visitor feel at home and puts him at his ease from the first moment. The Association is famous for its choice of speakers, both those who propose and those who respond to the toasts, and on Wednesday last it fully lived up to its reputation. There was not a dull speech during the whole evening, and though it would be impossible to refer to them all, special mention may be made of those delivered in reply to the toast of the "Bench and Bar" by the Hon. Mr. Justice Shearman, Mr. Alexander Macmorran, K.C., and Mr. H. P. Macmillan, K.C. It was a most enjoyable evening.

A 12,000-Volt Direct-current Generator.

EARLY experiments with high-voltage continuous-current machines for wireless work indicated that there were pulsations in the current, and investigations showed that the pulsations were due to faulty commutation. If the current be not properly commutated, extra currents react magnetically upon the exciting and commutating circuits, resulting in changes in the induced voltage.

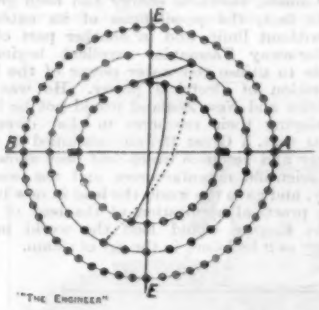


FIG. 1

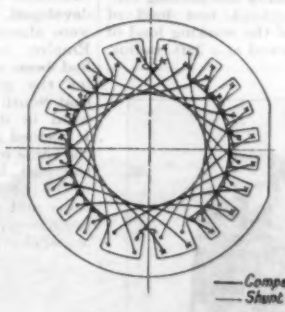


FIG. 2

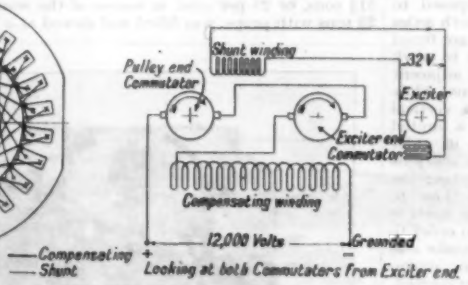


FIG. 3

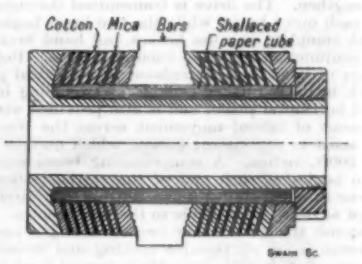


FIG. 4

Machines for this work must be built to withstand short circuits without flashing, for flashing at high voltage may seriously damage the commutator and brush gear. Another difficulty met with in the design of such machines is the limitation in the number of segments in the commutator.

A machine described by Mr. Bergman in the *Journal* of the American Institute of Electrical Engineers is said, however, to work satisfactorily, notwithstanding that the pressure between the commutator bars runs up to about 90 volts, or nearly four times the conventional value, and machines rated at 15 kilowatts at pressures up to 15,000 volts have been built. Two armature windings are employed, and each winding is connected to a commutator at opposite ends of the armature. It is well known that when commutation conditions are severe, as in motors which must operate over a wide range of speed, or in the case of machines which have to endure heavy and sudden fluctuations in load, the operation of direct-current machines can be greatly improved by employing a compensating winding for neutralising the armature reaction. A well-known form of compensated machine has a concentrated form of exciting winding with definite poles, and a compensating winding laid into the pole faces. Experiments have shown, however, that the performance of such a machine can be improved if both the exciting windings and the compensating windings are distributed. Mr. Bergman has found that by distributing the compensating and exciting windings in a certain way, it is possible to obtain results which are electrically perfect, whilst the mechanical construction is simple.

The diagram, Fig. 1, represents a two-pole machine. The inner circle represents the conductors of the armature winding, the middle circle the conductors of the compensating winding, and the outer circle the conductors of the exciting winding. The distribution of current in the conductors is shown by the usual crosses and dots, which indicate respectively that the current is flowing away from, or towards, the reader. The direction of the armature reaction is indicated by the line A B, and the compensating winding is arranged so that the current in each conductor is flowing in the opposite direction to the current in the opposite conductor in the armature. Accordingly, the compensating winding produces a resultant magnetomotive force in the direction B A, opposite to the armature reaction. The exciting winding is so arranged that its magnetic polarisation is along the line E E, and is disposed 90 electrical degrees in space from the line A B. The armature winding in Fig. 1 is shown as a full pitch winding, and under these conditions the compensating and exciting windings would naturally, also, be laid out as full pitch windings, in which case the end connections would be represented by the dotted line. The compensating winding would then be a counterpart of the armature winding, both mechanically and electrically. Mr. Bergman has found, however, that exactly the same distribution of the field winding can be obtained by the use of a 50 per cent. pitch winding, and a single coil is shown by the full line in Fig. 1. In Fig. 2 all the coils are shown, and it will be seen that in each slot there is a compensating coil as well as an exciting coil, and that all the coils together form, mechanically, a single winding similar to a lap winding used in the field of induction motors.

It is interesting to note that the armature reaction of a full-pitch armature winding is neutralised by a completely distributed half-pitch winding. Obviously, by the use of a half-pitch winding in the field, economy is obtained, because both windings exert exactly the same amount of magnetomotive force by the use of the same number of turns, but the length of the turns of the half-pitch winding is far shorter than in the full-pitch winding. From Fig. 2 it will be seen that the teeth of the field are evenly distributed, but one tooth on each side of the commutating tooth is left out, thereby producing a wide neutral zone. The compensating winding is made slightly stronger than the armature reaction, and the difference in ampère turns sets up a commutating flux through the commutating teeth. Experiments have indicated that the fully distributed exciting winding has the advantage of producing, approximately, a sine wave flux distribution, resulting in a gradual building up of the voltage gradient on the commutator. As the slots are open, it is possible to wind and insulate the coils outside the machine, and after the coils have been assembled steel wedges are inserted for closing the slots, but the wide slots on each side of the commutating pole do not contain steel wedges, as they would cause the commutating flux to leak sideways instead of penetrating into the armature. The main features of the new machine are (1) a simple single coil winding is used, and on account of the 50 per cent. pitch it is economical in material; (2) a single compensating winding is used, both for the purpose of neutralising armature reaction and producing a commutation field; (3) the exciting winding is fully distributed and close to the armature, and in addition to giving a sine wave flux distribution, it reduces leakage to a minimum, and (4) wide neutral points are provided so as to remove the flux from the coils undergoing commutation.

As stated at the outset, the armature carries two independent windings, each being connected to a commutator. The bottom winding, which has a larger self-induction than the top winding, reverses the current more slowly than the top winding, but this difficulty has been overcome by using thicker brushes for the bottom winding than are used for the top winding.

The diagram, Fig. 3, shows the connections for the machine, and it will be perceived that a separate machine is used for excitation. There are two reasons for employing a separate exciter, one being that it would be difficult to wind and insulate shunt coils for 6000 volts or more, and secondly, a sudden variation of the load would set up tremendous induction and cause a discharge through the armature, and the machine might flash over. Tests have shown that the machine possesses excellent operating qualities. Up to five times full load the commutation is perfect, and this load can be thrown on and off the machine without causing sparking or flashing. Moreover, the excitation can be applied without inserting resistance in the exciting winding, and instantaneous short circuits in wireless valves do not disturb the machine in the least.

During the construction of the machine, difficulties arose in connection with the construction of the commutator. Finally, however, the difficulties were overcome by building the commutator on the lines shown in Fig. 4. The underlying idea in that construction originated in the design of the American General Electric Company's Fabroil gears. The commutator segments are held together under heavy pressure between washers of cotton batting, and in order to obtain high dielectric strength mica washers are interspersed between these cotton washers. The commutator is subjected to a heavy pressure of about 5 tons per square inch, the total pressure applied to the commutator being 120 tons. As cotton possesses the characteristic of resiliency under heavy pressure, the pressure is maintained at all times and the commutator is, therefore, tight under all conditions. Thus, once the commutator has been completed, it need not be interfered with, and no tightening arrangements are provided.

A Small Motor Cruiser.

WE recently had the pleasure of making a trip in the new motor cruiser Lady Clare II., which has been designed by Norman Hart and Barham, naval architects and engineers, of Kingsbury House, King-street, St. James's, London, S.W. 1. The vessel was built by the Chester Boat Company, Limited, and formed a prominent feature on that firm's stand at the recent Shipping, Engineering and Machinery Exhibition. It was the subject of favourable comment on account of the carefully thought out design, and the way in which it was carried out, both as regards material and workmanship. We reproduce in Fig. 1 a photograph of the boat taken under full-speed conditions, and the drawings reproduced in Fig. 2 will serve to illustrate the manner in which the passenger accommodation and the machinery space have been arranged. The main dimensions are as follows:—Length on water line, 38ft.; beam, 9ft.; maximum draught, 3ft. 6in.; with a Thames measurement of 13 tons.

The outstanding feature of the design is the isolation of the engine-room from the other parts of the boat, so that the fore and aft cabin spaces and the whole space from stem to stern are readily accessible.

Right aft is placed the store space, with a 45-gallon fresh-water tank, reached through a hatch on the deck. The after cabin is most comfortably furnished with a pair of Pullman berths, which in the daytime may be folded back to form settees. Considerable ingenuity has been spent in fitting out the cupboard and wardrobe spaces, and a roomy little pantry is provided adjoining and forward of the after cabin. In the forward compartment there are two folding cots and ample locker accommodation. Folding doors lead to the forward wardrobes and the lavatory accommodation. As will be seen from Fig. 2, the engine is arranged amidship. It comprises a 3 D.C.R. Gardner petrol motor designed to develop 36 brake horse-power at

FIG. 1—THE MOTOR CRUISER LADY CLARE II.

800 revolutions per minute. The engine is combined with the firm's E type reversing gear, the whole of the machinery being bolted down to special girders carried the length of the engine-room. These, in turn, are fastened to pitch pine "fore and afters," which run the whole length of the boat. An electric starter and a 12-volt lighting dynamo, by S. Smith and Son, is provided, and all controls, with the exception of the starting switch, are carried to deck. The starting switch is placed immediately below the engine-room hatch, so that it cannot easily be tampered with by any unauthorised person.

A 2in. shaft to which the propeller is attached is supported on bronze stern tube bearings, which are packed at each end and are fitted for forced lubrication. The rudder is bronze, with a separate stock of gun-metal bar which turns on renewable bearings. By removing a nut and key the stock may be withdrawn upwards, and the rudder unshipped by dropping out the bottom supporting pin. The stem chain rollers form a departure from usual

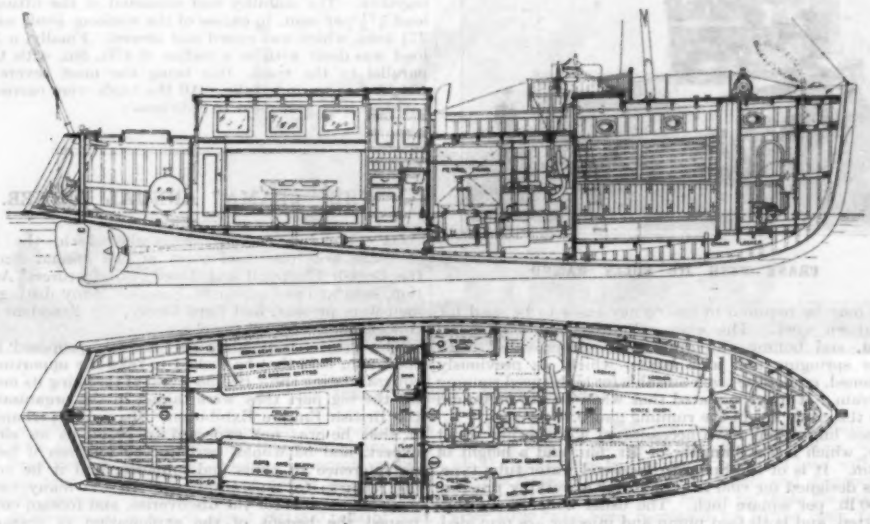


FIG. 2.—LONGITUDINAL SECTION AND PLAN OF THE LADY CLARE II.

practice, in that they are bolted through the stem, and any side pull is carried by the stem itself. Steel bulkheads are fitted between the various compartments. They are 14 S.W.G. in thickness, and are stiffened with 1in. by 1in. angles, the metal parts being galvanised after fitting. The steel plate is overlaid with felt and tongued and grooved teak.

The engine-room is entered from the deck by a short accommodation ladder, and on the main deck there is a water-tight hatch, through which access to the machinery is obtained. The hatch is only intended to be used for shipping the engines, and for inspection, repairs and overhauls. On each side of the after engine-room space are placed galvanised weldless steel fuel tanks. Each of the two tanks has a capacity of 100 gallons, and sufficient petrol is carried for a 300-mile run at full speed. A "Maxim" silencer is fitted on the engine, and the exhaust was noticeably quiet.

On the measured mile at Chelsea several runs were made, which showed that the boat has a mean cruising speed of a comfortable 8 knots with the engine running at 800 revolutions per minute. The steering was easy and steady, the vessel holding her course in a pleasing manner. The combined compass and steering gear was made by Henry Hughes and Son, Limited, the compass being of the firm's new deadbeat type. Three anchors and navigation lights are carried, and no effort has been spared to make the vessel seaworthy for both inland and coastal waters.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Politics and Trade.

THE trade position in the Midlands is unchanged. Iron and steel masters here are not greatly perturbed by the effect on business of the developments in the political arena and the great issue now facing the country. Some disturbance of trade they realise is inevitable, for the materialisation of prospective orders will necessarily be somewhat delayed. It is satisfactory, however, that the position having arisen, the dislocation will not be unduly prolonged. Midland manufacturers, most of whom have been hit more or less severely by foreign competition and dumping, await with a considerable measure of hopefulness the issue of the General Election, and it is hoped that the improvement which has set in in the iron and steel industry will continue unhampered by political controversies. The settlement of the dispute in the shipbuilding trade should make itself felt almost at once in this district, and manufacturers are anticipating a busier time, election or no election. At the moment demand keeps fairly good in most branches and values are very firm all round. In a few instances they show a definite advance on the week.

Forge Iron Improves.

The improvement in the pig iron branch of the Midland market continues, and this week demand for forge iron has improved. Hitherto this class of iron has participated to only a slight extent in the brightened outlook. There has this week, however, been rather more inquiry and values have firmed up. The minimum is now about £4 3s. 6d. for Northamptonshire and £4 4s. 6d. to £4 6s. for Derbyshire. Foundry numbers are moving off more freely, but the balance of supply and demand is not such as to enable smelters to enforce the further advance to which they think they are entitled. Derbyshire No. 3 iron continues at £4 12s. 6d. to £4 15s., according to brand, with Northamptonshire slightly lower. A good sign for the future is the desire of Staffordshire ironmasters to buy forward even as far as March next. No doubt the settlement of industrial troubles in the shipyards is partly responsible for the new attitude of ironmasters, who are now anxious to secure adequate supplies against the improved business which they are anticipating as a result of the settlement of the boilermakers' dispute. Makers of pig iron are not disposed to go beyond the end of the year, and in some instances will not go past November, in view of the unprofitable character of present rates. A feature of the new business is the number of foreign inquiries in Derbyshire for large tonnages of iron for delivery on the Continent. The Midlands are not well situated to compete for this class of business owing to the railway charges, in some cases amounting to as much as 13s. per ton. Apart from this, Derbyshire prices are several shillings below those of the Cleveland district for similar qualities. A furnace which had been damped down in Derbyshire is again making iron, but this appears to be the only development of production in this district.

Control of Steel Prices.

The association of manufacturers engaged in the production of steel plates and sections, which ceased to operate in August of last year, the competition for business having destroyed its authority and rendered it imperative that loyal members should be given a free hand, has again been called into existence. It is stated that the interests identified with the movement are sufficiently powerful to make the price declarations effectual. The price of ship, bridge, and tank plates has been fixed at £10, which is about the recent market level. Business is passing in angles at £9 15s., but it is not clear whether this figure has an official basis. Further efforts have been made to re-establish the Steel Bar Association and additional firms have been enrolled. A good many members of the trade think the time has arrived when price regulation might be again attempted with some prospect of success, but there are obstacles in the way which do not appear to have been surmounted yet. Producers who favour the establishment of an association have found themselves able to agree on a price advance, and they are now quoting £10 10s. to £11, a rise of 15s. to £1 per ton. Stability has not yet been attained, however, and prices a pound or more below the ostensible minima are being named. Whether the Association is to be reconstituted will depend presumably on how far solidarity is found attainable. Meanwhile makers generally are hopeful that the undue selling of competitors who prefer the free hand will gradually disappear. There has been a stiffening up of the market all round in recent weeks, and while not very long since orders of any size could be placed at £9 5s., £9 15s. would appear now to be the absolute minimum.

Further Advances in Steel.

The steel position has strengthened considerably. There is an improved demand for heavy engineering steel. Angles and joists now appear to be firmly established at £9 15s., a gain of 5s. in the past fortnight. Those firms that, last week, were prepared to accept £9 12s. 6d., now refuse business on that basis and ask for the full advance. Semi-finished steel continues very steady. Cutting is no longer as rife as it was formerly. Offers under £8 2s. 6d. cannot now be heard of, and the general level of business is £8 5s. Practically no foreign billets are on offer. Belgian makers are booked well into the New Year, and they are now adopting the policy of cultivating the finished steel business in preference to selling semi-finished. In spite of the large recent contracts for billets, many thousands of tons have been sold this week to re-rollers in South Staffordshire and the Midlands. There are still some remnants of a large parcel of continental billets, which was dumped in the district some time ago, on offer at about £7 12s. 6d., but none seems to have arrived since. A sharp advance has taken place in the price of small steel bars. Undercelling in this branch has long been prevalent and makers have grown tired of it. Recently, too, billets have been forced up against them, and it seems that an arrangement has now been come to whereby all those makers who are in favour of the re-establishing of the Steel Bar Association have raised the price of bars to £11 per ton. This is an advance of from 15s. to £1 per ton on recent quotations. There are, it is said, certain reservations which will permit of makers with stocks getting rid of them at lower figures. The makers consider the advance a safe policy and are going forward, despite the fact that bars are still being offered about £10. The steel trade has been agreeably surprised by the favourable nature of the Board of Trade returns, showing a production of steel ingots amounting to 702,100 tons, which is an increase on September and compares with 639,600 tons, the monthly average of 1913.

Steel Scrap Rising.

Steel scrap continues to rise in value, and this week quotations have ascended by a further half-crown. Sales are now being made at £4 10s., which shows a rise of about 15s. from the recent minimum price.

Nut and Bolt Bars Advanced.

The only movement of note in the Staffordshire manufactured iron trade during the week was an advance of half-a-crown in nut and bolt quality bars. More activity pervades the market for this class of bars than has been the case for many months. Both Staffordshire and Lancashire makers have received a gratifying tonnage of orders, and rolling has been resumed at one of the works in the Darlaston district, which has been doing nothing in this line for a considerable time. Prices accordingly have firmed up. Staffordshire makers have now advanced their quotation to £10 15s., and many of them ask £10 17s. 6d., which is the price Lancashire firms are demanding for bars delivered in the district. This has been an unremunerative branch for a long period, and makers are, now that order books are becoming better filled, showing more independence. Unmarked bars of Crown quality are still £12, but it is more difficult to get concessions. Demand is well maintained for marked bars at £14 10s. Belgian No. 3 iron for nut and bolt making can still be had at £8 17s. 6d. delivered, but consumers here have not much faith in the continental trade in the present disturbed conditions, and the major portion of the orders are going to local mills.

Sheet Mills Well Booked.

Makers of galvanised sheets are still booking orders and are now assured of activity during the first quarter of next year. There is no wavering in the £19 f.o.b. quotation for 24-gauge galvanised corrugated sheets, and substantial premiums are asked for prompt delivery, as is also the case for thinner gauges, which are in strong demand.

End of a Seven Months' Dispute.

There is a feeling of much satisfaction in Midland industrial circles that at long last a settlement has been reached in the boilermakers' dispute, which has for nearly seven months kept out of work some sixty thousand men employed in allied trades. Many Midland trades have been seriously affected, and it is hoped that the boilermakers' rank and file will loyally support their district and national leaders in their peace recommendation and thus enable work at the shipyards, which has been held up for so long, to be put in hand at once. Nut and bolt, chain and anchor, and other Staffordshire and Midland trades connected with the shipbuilding industry are anticipating the placing of good orders and are in many instances buying raw material ready for the execution of work which they hope at last to receive. One cannot help but regret the immense damage the boilermakers have done to themselves and to the engineering trades, apart from the suffering they have caused other workpeople.

Canal Boatmen's Dispute.

It is satisfactory that a basis of settlement of the canal boatmen's dispute has been found, and I am able to record that a number of the canal employees in Birmingham and the Midlands have now resumed work. A little time must necessarily elapse, however, before there can be a general resumption.

Midland Unemployed.

Again this week there is recorded a decrease in the number of unemployed in the Midlands. As compared with the figures for the previous week a decrease of 2081 is shown. In Birmingham the reduction amounts to 446. The industry most hardly hit in Birmingham is engineering, where there are approximately 15,000 out of work. This figure is far ahead of that of any other trade.

Automobile Engineers.

The first dinner of the Birmingham Centre of the Institution of Automobile Engineers was held in Birmingham on Monday. Mr. George H. Lanchester, the chairman, who presided, said that the fostering of the scientific development of the industry was the primary function of the Institution. If the trade in Great Britain was to maintain its supremacy, it was necessary for the industry to take advantage of all that science could give it. The council of the Institution arranged meetings at which men of science, leaders in the industry, men who ranked as authorities by reason of their outstanding ability, gave the benefit of their views to the members.

LANCASHIRE.

(From our own Correspondents.

MANCHESTER, Thursday.

General Outlook.

THE general improvement in the tone of the markets does not seem to be very much affected by the approach of the election, at any rate up to the time of writing, although one cannot suppose that such a political fight can take place without some very considerable disturbance of business. The actual volume of trade which will be done here up to the end of the year will probably be diminished, but a good deal of the buying of iron and steel material for the next two months has already been done, and both buyers and sellers can have a rest without any serious "sagging" effect on prices. Interest is now mainly directed to the question of probable prices and market conditions next year. Sellers, as a rule, are very confident that there is no possible chance of easier prices then, and consumers, in many cases, have acted upon this same belief by buying forward.

Metals.

The recent rise in the copper market is attributed to various influences, according as the critic takes a "bull" or a "bear" view of the future. One influence cannot be questioned, and that is the serious drop in the value of sterling as measured in gold, or what is practically the same thing, in American currency. Copper is dearer because our paper money, in which we measure it, is cheaper. It cannot be denied, however, that a larger volume of buying by the consumer is of some effect in the way of improving the copper situation, and this is, perhaps, of more importance than fluctuations of currency. If consumers are convinced that the holding of fair stocks of copper is a sound proposition, there is little doubt that the market will not fall back to any extent. The future, therefore, depends very much upon whether this confidence can be sustained. That there will be an increased consumption of copper in industry during next year is practically assured so far as this country is concerned, in consequence of the carrying out of the various railway programmes for the renewal of rolling stock. The point on the other side is whether or not producers of copper will continue to make more metal than can be consumed. At the present moment, the actual output of copper is in excess of trade requirements, but the excess balance is not great and may be covered by an increase in consumption within the next few months. Manufacturers of copper sheets and copper and brass tubes appear to have come to the conclusion that the recent advance in raw copper is to be maintained, and have now raised the official prices by £3 per ton in the case of sheets, rods and bottoms, and by ¼d. per lb. in the case of tubes. These advances, however, scarcely cover the increased value of the raw material. The market for tin has been fairly steady at the recent advance, which appears to have been caused by the buying on American account. This has now ceased for a time, and its withdrawal caused a slight set-back, but the position seems to be fairly sound so long as prices are not unduly forced up by speculation. The great strength of the market for lead continues, and there has been a tendency to reduction in the large backwardation on forward metal, which suggests that relief from the present stringency is not yet near at hand. Excessively high prices for sheet lead continue, and we have the curious spectacle of zinc sheets selling at £3 per ton below lead sheets, while spelter is worth £2 more than pig lead. Spelter has not participated in the advance in metals, and some people say that its turn is yet to come.

Pig Iron.

The market here for foundry iron is again a little quieter. This does not mean weakness, for there is no appearance whatever of weakness just now in the iron and steel markets; but, rather, less actual business is going on, and the price remains steady at 100s. delivered in Manchester. There are one or two brands of Derbyshire iron for which another 1s. may be asked, as almost all the makers stick to 92s. 6d. on trucks at the furnaces, and there are some small differences in the carriage rates. The recent buying of foundry iron by Lancashire consumers has extended as far as March delivery, and one hears occasionally that the consumer desires to cover himself for a whole year; but this is rare, and, as a matter of fact, Derbyshire makers are unwilling to sell ahead much farther than next March. Some ask a premium for extended delivery, and others prefer to be without such business. The advance in the selling price has been moderate, and is probably not sufficient to induce any of the idle furnaces in the Midlands to begin operations again; but there is a tendency in the Cleveland district to increase the output. Without being too positive on such a point, one is inclined to believe that the Cleveland makers of No. 3 iron have a larger margin of profit than the Midland makers. Scotch iron is firm here at £6 per

ton delivered, but one does not hear that there is any increase in the demand.

Finished Steel.

It is understood that very soon, if not this week, there will be a resumption of "controlled prices" in the manufactured steel trade, and, of course, this must mean a substantially higher level for a time. Some merchants have been securing steel during the last fortnight, perhaps with some knowledge that a renewal of the "control" was coming. It is a little difficult to say at what prices business could be done this week, but probably £10 10s. is near the mark for plates and £10 for angles and joists. For large round bars possibly £10 15s. to £11 might have to be paid. The improvement in bar steel prices will, of course, reflect on the manufactured iron trade, for the big gap between steel and iron bars has been a handicap to the Lancashire ironworks. If they will be content with the old prices, and not attempt to raise them with the advance in steel, it is possible that more work will come to the Lancashire iron manufacturers.

Scrap.

The prospect of more work for the iron people has already led to a rise in heavy wrought scrap, for which 95s. per ton delivered is now paid in Lancashire. There is not a great deal, and even at £5 per ton it will be the cheapest raw material for iron manufacture. Steel scrap is also firmer, and dealers here are talking of 80s. per ton for melting scrap on trucks at a Lancashire station. The demand for foundry scrap does not improve very much, but the dealers are certainly firmer, and for the best qualities of textile machinery scrap they quote from 92s. 6d. to 95s. per ton.

The Engineering Trades.

Although political affairs are at present absorbing the attention of the heads of engineering establishments in Lancashire, as elsewhere, the more active men are not allowing their energies to be diverted entirely to considerations of "Free Trade" and Tariffs, and I feel quite justified in saying that there is, on the whole, some general improvement. This is, no doubt, due in some measure to the promise of work for many branches of the engineering industry arising out of the recent Government schemes for railways, roads and shipbuilding, coupled with the confident anticipation that within a few days the boilermakers will resume work after their seven months' idleness. A considerable amount of business has also been placed in this country for materials for reconstructing the buildings, &c., which were wiped out by the recent earthquake in Japan. I am informed that one large firm of corrugated iron manufacturers at least will be kept busy for a considerable period on this class of work. On the whole, therefore, the outlook is distinctly brighter, and when the "election fever" has run its course still better times may be anticipated.

Institution of Mechanical Engineers.

The annual dinner of the North-Western Branch of the above-named Institution will be held on Thursday, December 7th. By permission of the Committee, the function will take place at the Engineers' Club in one of the new rooms, which is capable of accommodating over one hundred diners. By the provision of this fine room, the principal engineering societies will now be able to hold their meetings under pleasanter and more comfortable conditions than formerly and without depriving the members of the Club of the use of their smoke-room. It is essential that all members of the Institution of Mechanical Engineers who wish to be present should signify their intention as early as possible to Mr. Dempster Smith, the hon. secretary, Manchester College of Technology.

BARROW-IN-FURNESS, Thursday.

Hematite.

The general tone in the hematite pig iron trade is better, and although there have have been no additional furnaces put in, everything points to an increase in the production before the end of the year. As stocks are becoming exhausted at the various works, the tendency on the part of customers to place orders for forward delivery will increase, and already there are signs of business being done for other than immediate deliveries. Many buyers are still inclined to order in small tonnage just sufficient to meet immediate requirements, but this will alter as trade becomes better. Now that there is hope of the boilermakers' lock-out ending, a better feeling will exist in the engineering trades, and this will be reflected in the iron trade of this district. It is about time there was an improvement, for the present production is low. Trade with the Continent and America is not heavy, and the present improvement in business is due to home buying. Now that the steel works in the district are likely to be more regularly employed and the consequent consumption of iron increased, makers will be compelled to produce more metal.

Iron Ore.

The iron ore trade remains dull, and the various mines are only very moderately employed; but this condition will improve when more furnaces are put into blast. Cumberland is the busiest, but that is not saying much. Foreign ore is in moderate demand and likely to be for some time yet.

Steel.

The steel trade is keen and mostly on home account. The Workington rail mills have more to do, and the Cumberland firm is also engaged on steel sleepers. The Barrow rail mills have work for some months, and what will keep them employed will be orders for British railway companies. The hoop and section mills have plenty of work to keep them going.

SHEFFIELD.

(From our own Correspondent.)

Improvement in Heavy Steel.

THE improving conditions in the steel trade continue, and are benefiting both the heavy and the light branches. Complaints of the withholding of orders for open-hearth steel are less frequent. On the other hand, the Templeborough works and the Parkgate works have each lighted an additional furnace, and the local production of open hearth steel is now larger than it has been at any time during the last six weeks, with good prospects of increased work in the future. Prices have stiffened, particularly for soft billets. The heavy departments making railway supplies are also better employed. Several orders for axles, tires, and springs have lately been placed, and firms have received intimation that contracts for rails will be given out shortly. The great schemes of railway expenditure which have recently been announced have not materialised in actual work yet, but inquiries have been sent out and there is a general confidence that the orders will come along early in the New Year. A capital order for rolling stock is announced this week. Cravens Railway Carriage and Wagon Company, Limited, of Darnall, Sheffield, has secured a contract from the London and North-Eastern Railway Company for thirty-two carriages, to be used on the Cheshire Lines Committee's system. The vehicles comprise eight first-class carriages, eighteen third-class, two composite, and four third-class and brake carriages, and the complete order represents a sum of £100,000. The contract will provide work in the firm's carriage building department for a period of six months. It is only a few weeks since the same firm supplied a new train to the Mersey Railway Company.

The Lighter Branches.

The crucible steel trade continues to gain ground slowly, but has a long way to go before it reaches a normal state. As regards melting, forging, and rolling alike, a large amount of slackness still prevails, but it is generally believed that the worst of the slump has passed, and that a considerable revival may be expected during the next few months. A much improved state of things is reported in the finished branches, especially those devoted to the production of hand tools. The forthcoming big demands of the railway companies will involve a large consumption of Sheffield tools. Some of the firms producing hack saws, which are turned out in countless numbers in Sheffield, report an increasing demand during the last couple of months, which they read as indicating a stronger position of the engineering industry.

The Supply of Cutlery Blanks.

There is a little more activity at the large cutlery factories, and the small firms are well employed. The demand is chiefly for stainless knives, of which great quantities are being turned out. A good colonial trade is being carried on, especially with Australia, the shipments to which Dominion in October represented the largest value ever recorded and were equal to half the total exports to all countries. During the week a meeting of cutlery representatives has been held for the purpose of hearing a proposal, by an American firm, to install in Sheffield a plant for forging, grinding, and bolstering knife blanks by an intensive process. A supply of uniformly accurate blanks would thus be produced, and the goods would be turned over to the different firms to polish, colour, and finish. Before proceeding to put down an expensive plant the promoter naturally wishes to be assured of the co-operation of the Sheffield manufacturers. A demonstration of the intensive process—described as a sixteen to twenty-four hours' proposition for the three operations—was given, and the meeting ended with the understanding that the trade would at once be canvassed with a view to ascertaining the amount of support that was likely to be forthcoming. An interesting item is that, for the first time in the history of the trade, a cabinet of cutlery has been despatched overseas by aeroplane. The firm concerned was George Butler and Co., which had to execute an urgent order for France.

Electro-plate.

There is still a considerable amount of activity in this trade, but the demand is chiefly for the cheaper classes of goods, and competition is so severe that profits are cut very fine. The Christmas season trade is responsible for a very large demand for cheap cases of tea knives, tea and fancy spoons, while the call for cheap, unplated spoons and forks is on an enormous scale. The branches producing first-class hollow-ware are quiet. A fair number of orders are on hand for hotel and restaurant supplies. The boilermakers' dispute, by causing a stoppage of shipbuilding, has been responsible for a great falling off in orders for the equipment of new vessels with plate; but, now that this labour trouble is out of the way, an improvement is looked forward to.

Metropolitan-Vickers' Contract.

Sheffield is interested to learn of a large Russian contract which the Metropolitan-Vickers Electrical Company has secured, and hopes to benefit materially from it. The contract, which has been made with the Russian Government, and represents a sum of £400,000, is for the establishment and equipment of main generating and substations in connection with the extensive programme of electrical development recently decided upon. Two main stations are to be established at Moscow and will supply a large district around the capital with light and power. Another is to be erected in the Donetz basin, one of the principal iron and steel districts of Russia. The contract will take about a year to complete and will enable the Company to employ more hands at certain of its works. Some of the firm's departments for the manufacture of electrical machinery are situated in Sheffield.

Large Bequest to the University.

One of the largest bequests ever received by the University of Sheffield will come to it under the will of the late Sir Albert Hobson, the well-known steel and cutlery manufacturer, and ex-president of the Associated Chambers of Commerce, who died early this year. The total value of his estate has been proved at £146,374. He left an immediate legacy of £5000 to the University, and, after the payment of bequests to relatives and others, the ultimate residue of the estate to the same institution. It is anticipated that this sum will probably amount to upwards of £50,000.

More Colliery Progress.

Considerable progress is foreshadowed by the Denaby and Cadeby Main Colliery Company, Limited, which is making preparations for the development of the Parkgate seam at both its pits. In order to facilitate the progress at Denaby Main it has erected new concrete-encased headgear, which, when completely fitted up, will be of great interest. Men at the top of the shaft, despite the fact that it is an upcast shaft, will always be working in pure air. This has been secured by an arrangement of air-tight seals which effectively seal off the return air from the fresh air. A new winding engine is being put in, and to accommodate it a new concrete engine-house is being built, which, when completed, will considerably improve the output from the colliery. There is also to be a reorganisation of the screens. At Cadeby, which is the newer of the two collieries, a compressed air plant has been installed. The Parkgate seam has been reached at this pit and is declared to be better there than at Denaby. It will be developed next year, and the output is expected to increase steadily for the next two or three years, until eventually an additional 1000 men will be wanted, making the total number employed by the company 5000. It is anticipated that in order to accommodate the additional workmen the company will shortly undertake, either directly or indirectly, the erection of several hundred new houses at New Conisbrough.

An Experimental Relay Station.

All who are interested in the development of broadcasting will no doubt watch the career of the new relay station that has just been opened in Sheffield. The city does not possess its own broadcasting centre, and it has been a source of complaint among the wireless amateurs that, owing to the distance of the big stations, it was impossible to listen-in satisfactorily to their programmes without the aid of expensive valve installations. To meet this difficulty the British Broadcasting Company has established the Sheffield station, at which the programmes sent out from London, Manchester, and elsewhere are received and relayed. This enables local enthusiasts to pick up the transmissions with cheap crystal sets. The station is in the nature of an experiment, being the first of its kind in the country, and it is fully expected to prove a success.

NORTH OF ENGLAND.

(From our own Correspondent.)

Steel Price Control.

THE outstanding feature in iron and steel trade circles this week is the resumption of the control on steel prices, which has been in abeyance for about fifteen months. Negotiations with this end in view have been in progress for some time, and it is understood that the chief obstacle was the opposition of a big firm of South Wales manufacturers which has not fallen into line. The arrangement apparently is that the Scottish makers will not invade the English market and *vice versâ*. Numerous home prices are fixed, but there is to be free competition for export orders.

Cleveland Iron Trade.

There has been a recovery since the slight check to business occasioned last week through the political disturbance, and the demand for pig iron is much brisker. Still, many consumers are inclined to await the result of the elections before committing themselves far ahead to any extent, and some are content for the time being to take deliveries already arranged without increasing their stocks until after the turn of the year. Prices are firmly maintained, No. 1 being 107s. 6d., No. 3 G.M.B. Cleveland pig iron 100s., No. 4 foundry 99s., and No. 4 forge 98s.

Hematite Pig Iron.

The demand for East Coast hematite pig iron is very strong. West Coast prices having been advanced. East Coast makers are able to collar the market, some good sales being reported to Sheffield and South Wales. The chance of buying mixed numbers at 100s. 6d. seems to be fast fleeting. Possibly an order at that figure might still be placed, but some makers will not name below 101s. per ton.

Ironmaking Materials.

There has been quite a brisk business in the foreign ore trade this week. Consumers have been buying pretty freely in anticipation of increased consumption and prices are stiffening. Already 23s. 6d. per ton c.i.f. Tees has been paid for best Rubio ore, and sellers anticipating a further rise are in no anxiety to do business. The export market for fuel is very much stronger, and there is consequently less disposition to cut coke prices to local ironmasters. For good medium furnace kinds 38s. is now the general figure, delivered at the works, and there is no pressure to sell.

Manufactured Iron and Steel.

The demand for manufactured iron and steel, already active, has received a further fillip by reason of the prospective settlement of the shipyard dispute, and makers are receiving specifications from the shipyards. The arrangement regarding the control of steel prices is not likely to involve any serious increase in the quotations in this area, the only advance being that angles are up 5s.

per ton. Heavy steel rails are now quoted £9 per ton, and fish-plates £13 for big lots, but for small lots 10s. more is asked.

The Coal Trade.

There are no changes of importance in the Northern coal trade, the conditions remaining pretty much the same as they have been during the past few weeks. The export trade is not, perhaps, so brisk as far as the placing of new business is concerned, though the collieries are well booked up for a while ahead, and are kept at top pressure in supplying contracts previously booked. There are, however, loud complaints of the shortage of wagons and trucks in connection with the Dunston staiths. Many of the collieries are reported to be teeming coals on the ground, while numbers of vessels are lying at the staiths awaiting cargo which is held up for want of transport facilities. There is considerable discussion proceeding about the possible quantities of North Country coal to be booked for shipment to Germany as the result of the recent arrangements in London. It is, of course, largely now a question of price. But in any case the position of the market all round is likely to be improved. As a matter of fact, the tone has already stiffened in more than one direction. The steam coal section of the market keeps very firm. All screened sorts, both bests and seconds, are scarce and firm. Small steams of every class are equally heavy in demand and are steady. Durham gas coals are on the mend, with the market turning gradually in favour of the producers almost every day. The result is that all classes of gas coals are now steadier in tone. Coking coals are very firm at full quotations, while bunkers are also a shade better. The coke market continues to improve, and foundry makes are steadier. Gas coke of every make is firm.

More Furnaces in Operation.

The gradual increasing activity in the iron trade is reflected in the fact that another blast-furnace was put into operation on Wednesday at the Ayresome Ironworks, Middlesbrough, on the production of hematite. With two recently started at the Tees Bridge Ironworks, Stockton, the total of operating furnaces on the North-East Coast is now 42, as compared with 72 in normal times. The forty-two furnaces at present in blast comprise 14 on Cleveland iron, 13 on hematite, and 15 on other kinds of iron.

SCOTLAND.

(From our own Correspondent.)

Shipyards Ready.

The latest developments in the shipyard dispute have been hailed with satisfaction, and prospects of an immediate re-start are eagerly discussed. The shipyards on the upper reaches of the Clyde have a number of orders in hand, while establishments at Dumbarton, Port-Glasgow and Greenock also have a considerable amount of work to start on. When the boilermakers' strike commenced the Society had upwards of 40,000 members on the Clydeside, about the half of which number were then in employment, while other shipyard workers numbered about 90,000. An immediate re-start would absorb a considerable proportion of these workers, and it is estimated that the turn of the year would see the greater proportion of the unemployment at an end. The effect on kindred industries would be almost immediate and most welcome. In other Scottish centres, such as Dundee, sufficient work is on hand to give employment to a considerable number of shipyard workers. The General Election may interfere with re-starting arrangements, but will, of course, be over early next month.

Advantages of Mid-Scotland Canal.

In the course of a paper dealing with the Mid-Scotland Ship Canal, read at a meeting of the West of Scotland Iron and Steel Institute by a Glasgow engineer, it was stated that such a canal would mean that all iron and steel would be quoted at lower prices; plates and structural sections would be delivered at the yards on the Clyde and the Forth at prices which manufacturers under present conditions simply could not look at; foundry supplies would cost less and the whole engineering and shipbuilding industries would be placed on a new and better footing.

Steadier Pig Iron.

A steadier tone is noticeable in the prices of pig iron. The recent increase in demand has not fallen off, but the bulk of the business passing is on home account, export at present being extremely slow. Furthermore, most makers have considerable stocks on hand and outputs even on a restricted scale are not taxed to meet demands. Offerings of foreign pig iron have been mentioned, but the quantities recorded are of little account, while deliveries are uncertain.

Steel.

Progress at the steel works is slow, but the outlook is brightening. The demand for plates is still the least active, sectional material showing more life. Fair orders for steel rails have been placed in this district. Sheet makers have been doing well in light gauges for export, and galvanised sheets also have been very firm of late, and the works now report an improving demand for heavy sheets on home account. Japan is reported to be in the market for thin black and galvanised sheets. Extended deliveries are now the rule for light sheets, but this does not appear to cause any diminution in orders. Prices are all firm.

Better Position in Bar Iron.

The home consumption of bar iron continues to increase. The prospect of an advance in prices has caused some buying against future requirements, but in the meantime, though home prices are firmly held, there is no indication of an immediate advance. Export, on the other hand, has appreciated slightly, the price being somewhere between £11 2s. 6d. and £11 7s. 6d. per ton f.o.b. Glasgow. Re-rolled steel bars are firmer, both for home and export, and the rise in these quotations is probably not yet checked. The price is in the region of £9 to £9 5s. home and £8 17s. 6d. to £9 2s. 6d. per ton for export.

Coal—Firm Conditions.

The collieries in the West and East of Scotland are still in a firm position. Considerable orders for round fuel for export are still in hand, and supplies could not readily be obtained for upwards of ten days or more. Owners therefore continue to quote high prices for immediate or future deliveries. Business in the latter is consequently restricted, and only immediate requirements are negotiated for. Washed nuts have met a better demand during the past few days and have strengthened their position accordingly. Shipping tonnage has arrived more regularly and good cargoes have gone from East of Scotland ports to continental and Scandinavian destinations. Aggregate shipments for the past week amounted to 309,934 tons, against 280,429 tons in the preceding week and 321,648 tons in the same week last year. In the home market the bulk of the turnover is for public works and household requirements. Industrial orders are still very light.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

The position in the coal trade is rather better than it was a week ago, and the reason for this is that tonnage has come along, with the result that collieries are working more regularly. Previously, owing to the succession of gales, tonnage was badly delayed, and this played havoc with colliery stems. There was scarcely an undertaking that escaped the effects of the shortage of ready tonnage at some time or another, and, therefore, it was not surprising that prices were adversely influenced. It was quite a common occurrence to find idle loading berths at the docks, but the tonnage situation now being improved, there is a much steadier tone about steam coals. Values of large coals have not materially improved, but whereas a week ago it was easily to be seen that there were weak spots in the market, now they are rather the exception. Coalowners look forward to more active conditions from now to the end of the year, more especially as December will be a short month on account of the Christmas holidays, and it cannot be regarded as more than a three weeks' working month. It is practically certain that outputs will suffer to a material extent, and it may be that the General Election will also mean a restriction of production for a few days at least. The consequence is that stronger conditions are anticipated, in addition to which it is likely that most exporters will be anxious to get away their shipments as early as possible in the month rather than run the risk of meeting with difficulty in stemming later in the month. So far as the general demand is concerned, this has not expanded to any appreciable extent, but there is a better inquiry in one or two directions for monthly cargoes for shipment over the first three and six months of next year.

Third Shift Question.

The experimental period during which the third shift at South Wales ports operates comes to an end on December 4th, and the trimmers and tippers, who have recently been meeting to consider the matter, have definitely decided to give notice that the agreement is to terminate. The men, apparently, are very dissatisfied with the result of the working of this shift, and contend that it is not justified either by the shipments made or by their earnings. It cannot be pretended that the conditions in the coal trade have been anything like as good during the past six months as they were during the previous six or nine months, but, at the same time, there is no doubt that the employing interests can, on the information at their disposal, make out a very good case for the continuation of the extra shift. They can point to numerous instances of steamers being turned round much more quickly than would otherwise have been the case had only two shifts been in operation, and already the shipowners have taken the matter up, emphasising the necessity for its continuance.

Tin-plate and Spelter Trades.

It is reported that a well-known spelter works near Swansea is to be refitted with machinery of the latest pattern and restarted. This enterprise is in the hands of several well-known men who, in years past, have been associated with this industry. Should the report prove to be true, the recommencement of the works will mean the employment of several hundred men. As regards the Welsh tin-plate position, a member of the workmen's side of the Joint Industrial Council has expressed the view that there is not the slightest danger of a stoppage of the industry on account of the action of the engine-drivers and firemen giving 28 days' notice terminating contracts owing to their wage grievance. Their action was quite unofficial, and, moreover, it transpires that less than one-half the number of men employed had given notice. He has suggested that the firemen should send in claims for redress and advances in wages apart from the engine-drivers.

Colliery Combination.

The coal trade in this district was surprised by the announcement, made in the latter part of last week, that Guest, Keen and Nettlefolds, Limited, had made an offer to the ordinary shareholders of the Consolidated Cambrian, Limited, and of D. Davis and Sons, to acquire their shares. The basis of the offers is to allot two Guest, Keen and Nettleford ordinary shares of £1 each for every five Consolidated Cambrian ordinary shares, and to allot one Guest, Keen ordinary share for every five ordinary shares (5s. each) in D. Davis and Sons. The new shares, so allotted, will rank for Guest, Keen dividend as from January 1st next. Shareholders in D. Davis and Sons will receive a final dividend for the year ending December 31st next of 4½d. per share less income tax on their ordinary shares, but in the case of the Consolidated Cambrian, Limited, the directors state that the subsidiary companies have not earned sufficient profit to enable them to declare a dividend on the ordinary share of this company in respect of the year ending December 31st next. The terms of the offers provide that unless shareholders representing 90 per cent. of the ordinary share capital of each company accept them by the 30th inst., Guest, Keen and Nettlefolds, Limited, have the option of withdrawing the offers, this option to be exercised on or before December 14th. All three companies are, at the present time, closely linked up by the fact that several of the directors are on the boards of all three undertakings. In the event of the deal going through, Messrs. Guest, Keen will have the control of over 7,000,000 tons of coal per annum, while it is interesting to note that Sir D. R. Llewellyn, Mr. H. Seymour Berry, and other directors of Guest, Keen and Nettlefolds are the chief proprietors of another group of collieries, which have an annual output of close on 5 million tons. The deal will involve an addition of £984,652 to the ordinary share capital of Messrs. Guest, Keen and Nettlefolds, thus increasing it to £6,362,805, and the number of workmen in their employ will be brought up from about 14,000 to 32,000, while their wage bill will be brought up from 4½ millions to 10 million pounds per annum.

Current Business.

Comparatively little new business has come along during the past week, but the individual position of collieries is stronger on account of the fact that tonnage has improved. The outlook is much more promising for more active conditions during the remainder of this year. There are now comparatively few weak spots in the market so far as large coals are concerned, but in the case of small coals the market is distinctly firmer for the superior grades, this being due to the shortage of supplies brought about by the recent numerous stoppages of collieries. Patent fuel, however, is in quiet demand, and values show no alteration, but coke is rather better, as supplies are scarce and the demand fairly active.

THE INSTITUTION OF CIVIL ENGINEERS.

OCTOBER EXAMINATIONS, 1923.

PASS LIST (*INTERIM*).

The results of the Examinations held abroad will be announced later.

Preliminary (54).—A. Aitken, J. E. Alderson, W. F. Barrett, J. L. Bliss, D. L. Brown, T. F. Burns, H. W. Cameron, W. A. Clarkson, H. E. T. Compton, A. V. H. Crummack, R. H. Cunningham, L. I. Davis, G. S. Dewey, L. H. Dickerson, J. A. McK. Donnelly, J. Dossor, S. Feather, S. A. Findlay, H. M. Gibb, J. McP. Gordon, J. L. Hallett, G. W. Harding, J. F. Harrison, E. V. Hawkridge, H. S. Heath, D. E. Holden, S. E. Horner, D. J. Howe, D. J. H. Kelly, W. M. Laird, C. J. Macdonald, B. Maclean, J. D. Midforth, N. H. Pannell, E. B. Parker, J. A. Rose, A. C. W. Ryland, K. Seymour, D. B. Spalding, C. C. Stoyle, I. H. Strachan, B. G. Stuart-William, L. G. Sumpter, J. R. Thackeray, W. E. Thomas, H. A. Vallance, W. H. Vickers, F. L. Walker, A. W. Whiting, P. A. Wilkinson, J. E. Wilson, G. K. Wood, E. I. C. Wyllie, H. P. Yates.

Associate Membership (107).—*Whole Examination, Sections A, B and C* (4).—D. A. Dallas, G. Edwards, J. Warnock, W. Wilson.

Sections A and B only (30).—G. T. Allcock, T. Bell, H. P. Bishop, J. G. Campbell, A. B. Catling, D. E. Coles, B. V. Dilley, A. S. Gifford, R. F. Gladwell, F. H. Greenhough, C. Harper, L. J. D. Henly, R. B. Heseltine, A. A. Ismail, W. H. Jackson, O. Koan, W. H. Kelly, D. H. Lee, E. P. Little, A. Macnaghten, J. E. W. Monkhouse, E. B. S. Powell, F. G. Rule, N. J. Tatman, S. G. Taylor, J. E. Truzzell, J. Verity, J. D. Wall, F. J. Watkins, J. H. Willans.

Sections A and C (1).—C. F. Walker.

Sections B and C only (0).—F. C. Briggs, M. B. Buxton, W. Fidkin, B. T. Gibson, R. C. Gibson, W. Russell.

Section A only (43).—M. E. Adams, A. E. S. Alcock, R. Arbuthnott, O. A. T. Baker, K. G. Benham, W. E. C. Bird, E. C. Boden, M. G. Bucknall, C. N. Burns, M. A. Butler, C. A. F. Cairns, A. B. Cooper, P. W. Davey, S. J. Davies, H. S. Dawe, L. T. Edwards, A. J. Gardiner, E. Gill, S. Hazel, B. A. Hitchcock, M. R. James, J. L. Jeffree, C. C. Kirby, A. L. Linford, A. K. MacKereth, R. Mackrill, J. Manson, J. A. Manson, W. E. Marsh, H. S. Matthews, M. I. Mohamed, A. H. Pavitt, F. T. Peachey, C. A. Phillips, A. F. Simpson, F. S. Snow, J. F. Summersgill, H. L. Trees, G. E. Turpin, T. G. Vipond, C. G. B. Wale, B. E. B. Walker, E. H. Wild.

Section B only (28).—G. S. E. Barker, C. Bown, J. L. Broom, W. C. Budd, G. L. Carpenter, C. W. Davis, K. L. Forster, J. T. Hillier, R. K. Innes, W. F. James, J. O. Jones, J. H. McIlvenna, F. C. Martin, C. Mellor, A. B. Newby, P. Porteous, J. T. Robinson, R. Schofield, A. Selvadurai, C. B. Smith, A. W. Strang, S. Sweeney, S. M. Taylor, E. H. Vick, N. E. V. Viner Brady, W. E. C. Ward, A. J. Weale, A. W. Wilson.

Section C only (50).—W. N. Allan, B.Sc. (Glas.), L. B. Aylen, A. F. Baddeley, F. Blackburn, R. Blyth, B.A. (Cantab.), H. Bone, E. S. Bradley, R. G. Braithwaite, J. K. Brooks, T. B. Browne, B.Sc. (Eng.) (Lond.), F. H. Bullock, B.Sc. (Bristol), F. Clark-Turner, J. Comrie, B.Sc. (Edin.), N. S. Cox, B.Sc. (Eng.) (Lond.), S. J. Curtis, D. Dalgliesh, B.Sc. (Eng.) (Lond.), W. W. Davies, B.Sc. (Eng.) (Lond.), K. S. Dodd, B.A. (Cantab.), F. W. H. Downing, B.Sc. (Manchester), G. S. Dunkin, B.Sc. (Eng.) (Lond.), E. H. Fforde, A. C. H. Glase, W. R. D. Glennie, J. N. Gresham, J. A. K. Hamilton, B.Sc. (Edin.), J. B. M. Hay, B.Sc. (Glas.), R. B. Hilton, C. Hogg, B.Sc. (Glas.), T. R. Humble, V. R. Husband, B.Sc. (Eng.) (Lond.), H. Irwin, B.Sc., Tech. (Manchester), A. Johnson, S. M. Johnson, B.Eng. (Sheffield), E. W. Keer, M. Lewis, J. R. Malcolm, B.Sc. (Eng.) (Lond.), T. W. Marsh, B.Sc. (Eng.) (Lond.), N. H. Michell, P. Murray, B.Sc. (Edin.), A. Naylor, T. R. Nelson, J. W. Price, S. M. S. Ram, B.A. (Cantab.), W. L. Rigby, G. G. Sanderson, L. W. H. Savage, B.Eng. (Sheffield), C. W. Seddon, F. J. Tansley, A. C. Thirtle, J. A. van Heel, B.Sc. (Eng.) (Lond.), M. Wasi, A. Webster, A. P. Weir, G. Welch, B.Sc. (Eng.) (Lond.), G. W. Widnall, R. D. Wilkinson.

The Ruston-Hornsby Motor Car.—We are asked to state that the Ruston-Hornsby motor car, to which we referred in our last issue when describing the Motor Show at Olympia, was made at Messrs. Ruston and Hornsbys works at Lincoln, where, also, the firms' headquarters are situated.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	19/6 to 26/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	23/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	5 5 0	—
No. 1 Foundry	5 8 9	—
No. 3 Foundry	5 3 9	—
N.E. Coast—		
Hematite Mixed Nos.	5 1 0	5 1 0
No. 1	5 1 6	5 1 6
Cleveland—		
No. 1	5 7 6	5 7 6
Silicious Iron	5 7 6	5 7 6
No. 3 G.M.B.	5 0 0	5 0 0
No. 4 Foundry	4 19 0	4 19 0
No. 4 Forge	4 18 0	4 18 0
Mottled	—	—
White	—	—
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	9 2 6	—
North Staffs. Forge*	—	—
„ „ Foundry	4 13 6 to 5 0 0	
(3) Northampton—		
Foundry No. 3	4 12 6	—
„ Forge	4 3 6	—
(3) Derbyshire—		
No. 3 Foundry	4 12 6 to 4 15 0	
Forge	4 4 6 to 4 7 6	
(3) Lincolnshire—		
No. 3 Foundry	4 13 0	—
No. 4 Forge	4 10 0	—
Basic	4 11 0	—
(4) N.W. Coast—		
N. Lancs and Cum.—		
Hematite Mixed Nos.	5 15 0 (a) / 6 0 0 (b)	— / —

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 0 0	—
Best „	—	—
N.E. Coast—		
Crown Bars	12 0 0	—
Tees	10 0 0	—
Lancs.—		
Crown Bars	12 0 0	—
Second Quality Bars	11 5 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	12 0 0	—
Best „	13 0 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	12 0 0 to 12 10 0	
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	10 15 0 to 10 17 6	
Gas Tube Strip	12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	13 0 0	—
Ship Plates, ½in. and up	9 15 0	—
Sections	9 10 0	—
Steel Sheets, 3/16in. to ½in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	19 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	9 15 0	—
Angles	9 10 0	—
Boiler Plates	13 0 0	—
Joists	9 10 0	—
Heavy Rails	9 10 0	—
Fish-plates	13 0 0	—
Channels	9 5 0	—
Hard Billets	10 5 0	—
Soft Billets	9 0 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 17 6†	—
Light „	9 7 6 to 9 17 6†	
Billets	8 10 0 to 11 10 0†	
Manchester—		
Bars (Round)	10 10 0 to 10 15 0	
„ (others)	10 5 0 to 10 7 6	
Hoops (Best)	15 5 0	15 0 0
„ (Soft Steel)	13 15 0	13 10 0
Plates	10 5 0 to 10 10 0	
„ (Lancs. Boiler)	13 10 0	—
Sheffield—		
Siemens Acid Billets	12 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	10 5 0	—
Intermediate Basic	10 0 0	—
Soft Basic	8 10 0	—
Hoops	12 10 0	—
Soft Wire Rods	11 10 0	—
Midlands—		
Small Rolled Bars	10 10 0 to 11 0 0	
Billets and Sheet-bars	8 2 6 to 8 5 0	
Gas Tube Strip	10 10 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	19 0 0 to 19 5 0	
Angles	9 15 0	—
Joists	9 15 0	—
Tees	10 15 0	—
Bridge and Tank Plates	10 0 0 to 10 5 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	23/1½ to 26/-
Block Tin (cash)	221 5 0
„ (three months)	221 15 0
Copper (cash)	61 0 0
„ (three months)	61 12 6
Spanish Lead (cash)	30 5 0
„ (three months)	29 2 6
Spelter (cash)	32 5 0
„ (three months)	32 11 3
Manchester—	
Copper, Best Selected Ingots	66 0 0
„ Electrolytic	68 0 0
„ Strong Sheets	95 0 0
„ Tubes (Basis price)	0 1 1½
Brass Tubes (Basis price)	0 1 0
„ Condenser	0 1 2½
Lead, English	32 10 0
„ Foreign	30 5 0

FERRO ALLOYS.

(All prices now nominal.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/9 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	10/6
„ 6 p.c. to 8 p.c. „	£22 0 0	8/-
„ 8 p.c. to 10 p.c. „	£21 0 0	8/-
„ Specially Refined		
„ Max. 2 p.c. carbon	£50 0 0	18/-
„ „ 1 p.c. „	£60 0 0	21/-
„ „ 0.75 p.c. carbon	£65 0 0	22/6
„ carbon free	1/6 per lb.	
Metallic Chromium	4/- per lb.	
Ferro Manganese (per ton)	£18 for home, £20 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/- per unit	
„ „ 75 p.c.	£18 0 0 scale 6/- per unit	
„ Vanadium	19/- per lb.	
„ Molybdenum	9/- per lb.	
„ Titanium (carbon free)	1/- per lb.	
Nickel (per ton)	£130	
Cobalt	11/6 per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

	Inland.	Export.
Scotland		
Lanarkshire—		
(f.o.b. Glasgow)—Steam		22/6
„ „ Ell		23/6
„ „ Splint		24/- to 26/-
„ „ Trebles		23/-
„ „ Doubles		22/6
„ „ Singles		19/6
Ayrshire—		
(f.o.b. Ports)—Steam		22/6
„ „ Splint		24/-
„ „ Trebles		23/-
Fifeshire—		
(f.o.b. Methil or Burntisland)—Steam		22/3 to 24/3
Screened Navigation		28/-
Trebles		24/- to 25/-
Doubles		23/-
Singles		20/6
Lothians—		
(f.o.b. Leith)—Best Steam		24/-
Secondary Steam		22/-
Trebles		24/6
Doubles		23/-
Singles		20/6
England		
(8) N.W. Coast—		
Steams		29/-
Household		46/6 to 57/6
Coke		43/6
Northumberland—		
Best Steams		25/- to 26/6
Second Steams		22/6 to 23/-
Steam Smalls		15/- to 16/6
Unscreened		20/6
Household		25/- to 28/-
Durham—		
Best Gas		24/-
Second		22/6 to 23/6
Household		25/- to 28/-
Foundry Coke		50/- to 52/6
Sheffield	Inland.	
Best Hand-picked Branch	31/6 to 33/6	—
Barnsley Best Silkstone	27/6 to 29/-	—
Derbyshire Best Brights	27/- to 29/-	—
„ „ House	23/- to 24/-	—
„ „ Large Nuts	21/- to 22/6	—
„ „ Small „	15/- to 16/-	—
Yorkshire Hards	21/- to 23/-	—
Derbyshire „	20/- to 22/-	—
Rough Slacks	11/6 to 13/6	—
Nutty „	10/- to 12/-	—
Smalls	5/- to 8/-	—
Blast-furnace Coke (Inland)	30/- to 31/-	
„ „ (Export)	f.o.b. 35/- to 36/-	
Cardiff—	(9) South Wales.	
Steam Coals:		
Best Smokeless Large		27/6 to 28/6
Second „		26/6 to 27/-
Best Dry Large		27/- to 28/-
Ordinary Dry Large		26/- to 27/-
Best Black Vein Large		26/6 to 27/-
Western Valley „		25/- to 26/-
Best Eastern Valley Large		24/- to 25/-
Ordinary „ „		23/- to 24/-
Best Steam Smalls		18/- to 19/6
Ordinary „		17/- to 18/-
Washed Nuts		27/6 to 30/-
No. 3 Rhondda Large		28/- to 29/-
„ „ Smalls		24/- to 25/-
No. 2 „ Large		23/- to 24/-
„ „ Through		18/6 to 19/6
„ „ Smalls		16/- to 17/-
Coke (export)		42/6 to 50/-
Patent Fuel		29/- to 32/-
Pitwood (ex ship)		29/- to 30/-
Swansea—		
Anthracite Coals:		
Best Big Vein Large		40/- to 45/-
Seconds		34/- to 36/-
Red Vein		32/- to 33/-
Machine-made Cobbles		52/6 to 55/-
Nuts		52/6 to 55/-
Beans		45/- to 46/-
Peas		26/- to 27/-
Breaker Duff		12/9 to 13/-
Rubbly Culm		14/- to 14/6
Steam Coals:		
Large		24/- to 25/-
Seconds		22/- to 23/-
Smalls		14/- to 16/-
Cargo Through		19/- to 21/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow.

(8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b

* Quotations extremely high and nominal. † Latest quotations available. (a) Delivered Sheffield or Glasgow. (b) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

The Ruhr Situation.

The continued optimistic feeling with regard to the future, now that the difficulties in the Ruhr are declared to be on the eve of settlement, has certainly not improved business to any appreciable extent. The fact that the volume of trade should be large, despite those difficulties, proves that there would be a considerable industrial activity if the situation were relieved of the disturbing elements incidental to the occupation. The vast amount of work to be done in this country constitutes, in fact, the basis of an industrial prosperity which is only waiting for an improvement in the financial position to take effect. Unfortunately, if the general outlook is good, the active revival which was foreshadowed on the cessation of the passive resistance in the Ruhr has not yet materialised, and the official statements that agreements are being made for the co-operation of the German magnates have been so often falsified by events that a systematic exploitation of the Ruhr seems to be as far off as ever. It is true that the French have succeeded in preventing any reduction of the coke output, but they admit that nothing more can be done without German aid, and it is significant that at a time when it was hoped that the country would have abundant supplies of coke, the price has had to be further advanced. The late tendency towards a downward movement in iron and steel prices has therefore been arrested, and in some cases values are hardening, one contributory factor being, no doubt, the further depreciation of the franc, which has advanced the cost of imported fuel and raw material. At the same time, it is claimed that the fall in money values to very near the record level is bringing in many foreign inquiries for all kinds of manufactured goods. To that extent the high exchange rate is not regarded as a misfortune, and is certainly one of the reasons for the steady development of the export trade.

Iron and Steel Production.

The Minister of Public Works has declared that France is now the largest iron and steel producer in the world, and taking into account the iron ore deposits of Lorraine with those of the Briey there is certainly no reason why this country should not take the lead in raw iron production, if only it could be assured of sufficient supplies of coke. Despite the difficulties in the way of procuring coke, the production of pig iron is only a little below what it was before the Ruhr occupation. On October 1st last there were 111 furnaces in blast, or five less than on January 1st, and the production in September amounted to 481,874 tons, a decline of 4376 tons, as compared with the figure for December, 1922. The steel production in September totalled 446,480 tons, and, while rather less than in the previous month, was 31,883 tons more than in December.

Wagons.

Builders of railway rolling stock are so destitute of work that they are looking with satisfaction to the orders being given out by the railway companies, including one for 4500 wagons for the Chemins de Fer de l'Est. This, however, is totally inadequate for the manufacturers, who fear that they will have to discharge a large number of hands during the winter unless the situation improves, and they are consequently making great efforts to secure some of the orders being offered by Eastern European countries. Poland is inviting tenders for 5000 trucks of 20 tons. French makers do not expect to be able to compete with firms in other countries on the score of price, and an appeal has therefore been made to the French Government to intervene on their behalf on the ground that as this country has advanced so much money to Poland, it might reasonably be expected to give preference to French makers for the supply of rolling stock. Seeing that Germany surrendered to France a considerable number of 20-ton trucks, for which no use can be found in this country, it is proposed to offer the surrendered trucks to Poland on condition that the order for 5000 vehicles is placed with French builders, and the German trucks would be replaced by the French wagons as they are constructed. Builders would be very glad to see the last of the German trucks, which have long been an incubus on the home wagon-building industry. The necessity to secure foreign business is becoming more and more imperative in other branches of the engineering trades, in which the enormous increase in productive capacity has far outstripped the present home requirements, and during the past week a 15 million franc debenture issue has been made by Messrs. Schneider et Cie., with the assistance of the Hungarian Government and a group of French banks, for the construction of the free port at Budapest.

Automatic Couplings.

Soon after the Armistice the Government resumed the trials of automatic couplings for railway coaches which had been interrupted by the war, and after eliminating a large number of competing apparatus, selected for final test the Henricot and the Boirault systems, of which a description was published at the time in THE ENGINEER. The final tests of these two couplings are now being carried out, and when they have been concluded a report will be presented to the Superior Railway Council on the relative merits of the two systems.

Armoured Cars.

A new development in armoured car construction is being made by M. André Citroen, who is utilising the Citroen-Kergesse endless track chassis of the type that crossed the Sahara Desert last winter, and has since been adapted to a number of purposes. The chassis carries a turret similar in design to that of the small Renault tanks, and its speed and rapidity of handling must make it an effective weapon, while the facility with which the cars can be turned out suggests the possibility of their modifying the conditions of warfare in the future—if wars there should be. In the production of war material, manufacturers are by no means inactive.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

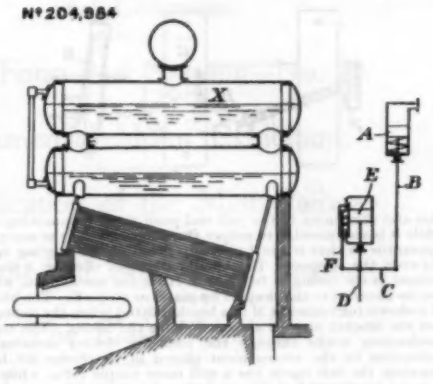
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

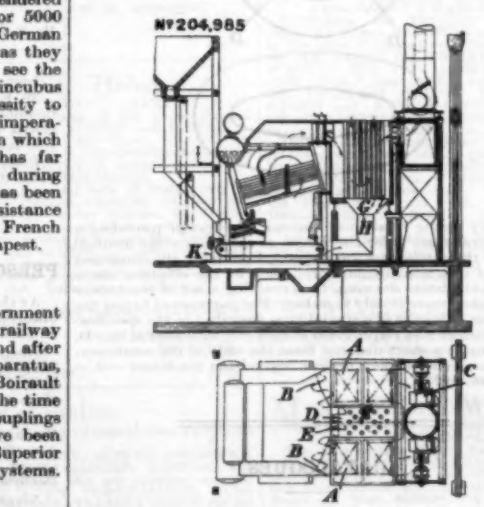
204,984. December 28th, 1922.—IMPROVEMENTS IN AND CONNECTED WITH STEAM GENERATING INSTALLATIONS, *Babcock and Wilcox, Limited, of Oriel House, Farringdon-street, E.C.* 4.

The invention relates to steam generating installations comprising a boiler, to the steam and water drum of which is connected an overhead or storage drum X giving an enlarged boiler water space. To permit the maintenance of a supply of high-pressure steam over a substantial period without a proportionate drop in pressure and without an increase in the rate of firing, it is desirable to provide for automatic regulation of the feed to the boiler so that the supply of feed water to the boiler may be reduced when the boiler pressure commences to fall. For regulating the feed a piston is used, which moves in response to variations in the boiler pressure. The boiler pressure acts on a spring-controlled piston A, the piston-rod B of which is connected to one end of a lever C, which is pivotally connected between its ends to a rod D connected at one end with a feed water regulating member (not shown) and at the other end with a piston E. The piston moves in a cylinder and the distributing slide valve F of which is also pivotally connected with the lever C. This servo-motor valve gear operates in such manner that on displacement of the slide valve F by the piston A the piston E controlling the feed water regulating member is correspondingly moved. By the adoption of this device it is possible to maintain at any time uniform operation of the furnace, which is a necessary condition for ensuring the maximum efficiency of the boiler installation. The feed water passed through the economiser during the period when the boiler feed is stopped may be stored in a separate collector and utilised on resumption of the normal feed.—*December 28th*, 1922.



204,985. December 28th, 1922.—IMPROVEMENTS IN AND CONNECTED WITH STEAM GENERATING INSTALLATIONS, *Babcock and Wilcox, Limited, of Oriel House, Farringdon-street, London, E.C.* 4.

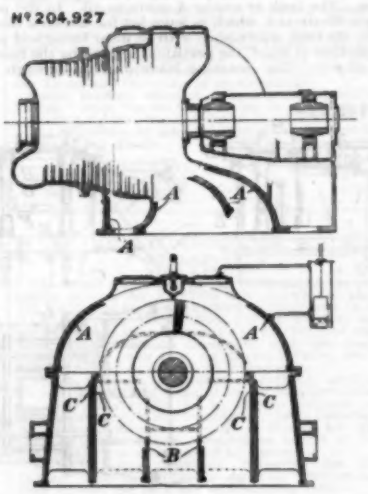
This invention relates to steam boiler installations of the type including a feed water economiser, in parallel with a preheater for preheating the air for combustion in the boiler furnace, and dampers controlling the passage of the flue gases through the economiser and air preheater in such manner that the gases may be directed through either the feed heater or air preheater alone or through both the feed heater and air preheater simultaneously. According to the invention, two feed-water heaters are used in conjunction with the air preheater, and controlling means are provided whereby the flue gases may be led alternately through both feed-water heaters alone or the air preheater alone or through both feed-water heaters and the air preheater simultaneously. Behind the boiler furnace there is a sectional economiser A, through which the flue gases can be allowed to pass by operation of dampers B, these gases being then drawn off by an induced draught plant C arranged beyond the economiser. Between the economisers A there is a by-pass flue D, which can be cut off or opened by the operation of dampers E and which also leads to the induced draught installation. In the by-pass flue there is a large number of tubes F, which at their lower ends enter a box G connected to the lower side of the grate by means of a duct H. The front part of the grate is shut off from the atmosphere by means of a casing K. Under normal conditions the dampers B are opened and the dampers E closed, so that the flue gases are drawn off through the economiser and they heat the feed water. When, however, the feed is interrupted the dampers B are closed and the dampers E opened, so that the flue gases flow through the air preheater formed by the tubes F to the induced draught fan. The air for combustion purposes is drawn through the tubes F and thereby preheated and passes through the piping H to the part of the boiler furnace under the grate, where, after forcing its way through the layer of fuel, it produces, by virtue of its increased temperature, an increase in the combustion temperature of the boiler installation.—*October 11th*, 1923.



TURBINE MACHINERY.

204,927. October 26th, 1922.—IMPROVEMENTS RELATING TO STEAM TURBINES, Karl Baumann, of Northwood House, Barnfield, Urmston, Lancaster, and Metropolitan-Vickers Electrical Company, Limited, of 4, Central-buildings, in the City of Westminster.

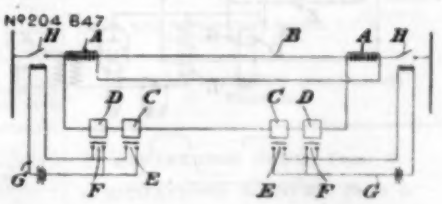
The present invention has for its object to prevent the exhaust or low-pressure end of a turbine attaining an excessively high temperature under any condition of operation. In the particular application of the invention illustrated) metallic plates A are bolted along their lower edges to various parts of the wall of the exhaust casing and to the inner ribs B, the spaces between these plates and the parts to which they are attached being closed at the ends, and series of holes C are drilled from opposite sides of the outer double ribs to the spaces formed between the parts of the latter. In operation, the pockets formed between the plates A and the parts of the turbine to which they are attached and within the double ribs are maintained full of water, and so long as the steam flowing through the exhaust casing is saturated, the water is simply maintained at the temperature of the steam. If, however, the steam is superheated or acquires that condition owing to heating within the turbine cylinder, the water within the pockets evaporates and cools both the ribs 3 and 4 and the exhaust casing and also the steam flowing through the latter. The water level within the pockets may be maintained in any suitable manner.—*October 11th*, 1923.



TRANSMISSION OF POWER.

204,047. February 23rd, 1923.—IMPROVEMENTS IN OR RELATING TO ELECTRIC PROTECTIVE SYSTEMS, Electrical Improvements Limited, of Milburn House, Newcastle-upon-Tyne, and James Robert Beard, of The Oval, Benton, Northumberland.

This invention relates to protective systems for electric conductors, of the type in which the operation of trip coils or circuit-breaking devices is brought about when the balance of current or voltage in a pilot circuit is disturbed. Protective systems of this type, however, have the disadvantage that, if the relays are sensitive, they will sometimes operate to cut out a sound conductor in response to capacity currents, or other effects resulting from the passage of heavy straight-through currents due, for instance, to the occurrence of a fault in some other part of the system. This invention has for its object to provide an improved protective system of the above type which is not subject to this disadvantage. The pilot circuit comprises at each end the secondary A of a transformer, the primary of which is in circuit with the main conductor B and a pair of relays C D in series with one another. One relay C of each pair is made highly sensitive, whilst the other D is relatively insensitive. The relays C and the control switches E and F respectively are in a trip circuit G, which controls the switch H in the main conductor B. The arrangement of the trip circuit is such that if either relay closes its switch E or F the circuit will be completed and the main switch H will be opened. In normal conditions the two transformer secondaries A in the pilot circuit balance one another, and no current flows in this circuit. This balance will be disturbed on the occurrence of a fault in the conductor B, and may also be disturbed, owing, for instance, to capacity currents, when a heavy straight-through current is flowing through the conductor, such, for example, as may be produced as the result of a fault in a neighbouring conductor. In the latter case, however, the disturbance is only temporary, and the normal balance will be restored after a short interval. The sensitive relay C is a time limit relay, and is given a time setting which is greater than the time taken to restore the normal balance in the pilot circuit after a disturbance due to a heavy straight-through current. The relay D, on the other hand, is quick acting, but is made so insensitive that it is unaffected by the out-of-balance effect resulting from a heavy straight-through current. Thus, when such a current flows in the main conductor B, the balance in the pilot circuit will be disturbed to an extent sufficient to operate the relays C, but insufficient

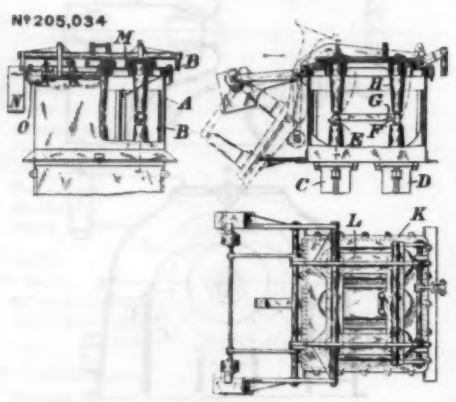


to operate the relays D. The balance in this circuit will, however, be restored before the relay C has had time to act on its switch E. The trip circuits G will, therefore, remain inoperative, and the conductor B will be kept in circuit. When a fault occurs in the conductor B, the balance in the pilot circuit will again be disturbed. The relays C will respond at once to this disturbance, but will not act on their switches E until their time limit has elapsed. If the fault is a serious one, however, the want of balance in the pilot circuit will be sufficient to operate the relays D, which will act at once on their switches F to complete the trip circuits and cut out the main conductor B. For a very small fault, the balance in the pilot circuit may not at first be sufficient to operate the relays D, but these relays will operate to cut out the conductor if the fault becomes at all serious. In any case, the conductor will be cut out by the relays C after the expiration of the time limit.—*October 4th*, 1023.

SWITCHGEAR.

205,034. July 3rd, 1922.—Improvements in or relating to Oil-immersed Electric Switch Fuses, Henry William Clothier, of The Green, Wallsend-on-Tyne, Northumberland, and James Mirrey, of "Nyong," Sunderland-road, East Boldon, Durham.

According to this invention, an oil-immersed switch fuse has a tank or casing made to resist heavy internal stresses and provided with a strong lid which is in two parts, one fixed to the tank and the other carrying the fuse or fuses, which, when the movable part of the lid is opened, pass through slots in the fixed portion. The tank or casing A contains oil. In the particular example illustrated, which is intended for use on a three-phase system, the tank is furnished with an inner lining and partitions B, preferably of wood, the partitions separating the fuses for the three phases. The incoming leads pass up through boxes C

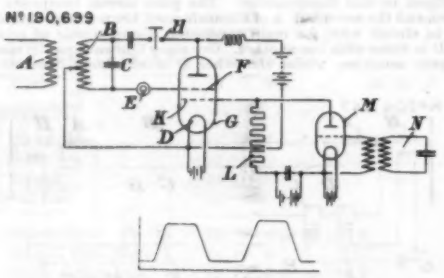


and the outgoing conductors pass out through other boxes D. These incoming and outgoing conductors terminate in fixed contacts E and F, which, when the lid or cover of the tank is closed, receive the ends of a fuse G carried by insulators H. The lid is in two parts, one portion K being normally clamped tightly down over the tank by means of studs, whilst the other portion L, which carries the insulators H and fuses G, is hinged or pivoted so that it is movable relatively to the normally fixed portion of the lid and the tank. The fixed portion K of the lid is provided with openings as at M, through which the insulators H and the fuses G can pass. A gas-tight joint is made between these openings and the portions of the movable lid which rest upon them when that lid is closed. The weight of the movable lid is counterbalanced by weights N and supplementary weights O are provided for overbalancing the lid.—*October 3rd*, 1923.

TELEGRAPHS AND TELEPHONES.

190,699. September 26th, 1922.—Improvements in High-frequency Telephony, Gesellschaft für Drahtlose Telegraphie m.b.H., of 9, Tempelhofer Ufer, Berlin.

This invention relates to high-frequency telephony, and its object is to provide a system in which transmission and reception on the same wave length of carrier wave may be possible without switching operations. Means are provided whereby the valve which generates the carrier waves is for short intervals prevented from oscillating so that it can act as a receiver, the intervals succeeding one another so rapidly that they do not prevent speech at either station being heard at the other. A is a conductive circuit or antenna, B a coil forming with the condenser C an oscillatory circuit in which undamped oscillations are

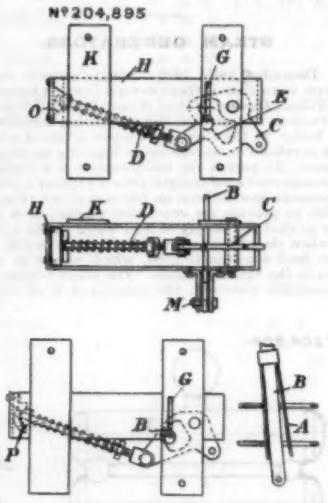


generated by a two-grid valve D. E is a microphone in the lead to the control grid F of the valve G, while H is a telephone in the anode lead. The space charge grid K is connected to an ohmic resistance L in the anode circuit of a valve M, by means of which and of an auxiliary generator N a voltage of the form shown by the curve can be impressed on the grid K. This voltage influences the anode current in valve G. It reduces the normal space-grid voltage for a given time and then allows it to rise. When the anode current is small the valve stops oscillating and operates as a receiver, whilst when the anode current is large the valve operates as a generator. The valve will thus be operating sometimes as a transmitter and sometimes as a receiver.—*October 11th*, 1923.

TRAMWAYS AND RAILWAYS.

204,895. October 2nd, 1922.—Improvements in or relating to Self-reversing Ground Levers for Railways and the like, Llewellyn Wynn Williams, B.Sc., of Greencroft West, Darlington.

This invention relates to two-way self-reversing levers of the movable handle type for railways, and the inventor's primary object is to provide means of cushioning for the purpose of taking up the blow caused by the reversing of the handle when the points are forced open trailing-ways by a wheel flange of a passing vehicle. Another object is to modify the construction of the existing bell-crank lever for the purpose of giving smooth and efficient working to minimise the blow and friction on the handle. The cushioning arrangement may consist either of spring blades A fitted on each edge surface of the handle B towards its lower portion, or springs may be fitted in a slot formed in the bell crank C. To facilitate the action of the usual toggle mechanism D and in order to minimise the blow on the handle B during the action, the inventor modifies the bell crank C by the provision of a long slot E. With this arrangement the movement of the handle is at right angles to the toggle mechanism,

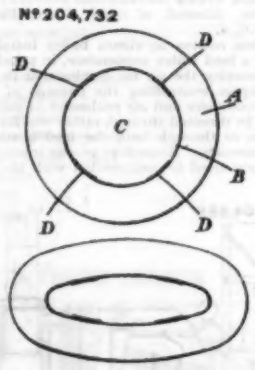


this also pertaining to the pull and push by the connecting-rod, while it is also possible to reduce the dimensions of the complete apparatus so that it can be readily fitted in the existing space between the sleepers. The handle B passes through a slot G formed in the casing or framework H for the mechanism, which can be fastened to the sleepers by plates or strips K. The handle B is shown fulcrumed at M in a bracket fitted below the casing H, but the bracket may be arranged above the casing. The toggle mechanism works through the conically drilled member O. According to the arrangement shown in the lower left-hand drawing, the bell crank has a still more simple form, while the housing for the end of the toggle has been simplified, as shown at P.—*October 11th*, 1923.

MISCELLANEOUS.

204,732. April 8th, 1922.—Improvements in or relating to Electrical Condensers, The Telegraph Condenser Company, Limited, and William Joseph Cole, both of Vauxhall-street Kennington-road, London, and Sidney George Brown, of Victoria-road, North Acton.

The condenser is composed of coil elements. A is the condenser coil comprising the usual strips or sheets of thin flexible metal or metal-coated paper with separating insulating strips, wound into a tight coil. B is the former, which may be in the form of a tube of thin sheet metal or of other material which is



sufficiently strong to support the coil, the former providing a clear central space C for circulation of the oil or other medium in which the condensers are placed. Preferably the condenser is pressed into non-circular form, such as the elliptical shape shown in the lower drawing, thus enabling a set of condensers to be packed more closely together. For purposes of fitting the condensers in frames of a special type described in the specification the former may be provided at each end with a set of lugs D, which project a short distance from the ends of the condenser. Or the former itself may project beyond the condenser coil.—*October 8th*, 1923.

CATALOGUES.

The Paterson Hughes Engineering Company, Limited, Glasgow.—Illustrated List No. 7 of "Phec" conveyors and veleators.

Wm. Johnson and Sons (Leeds), Limited, Armley, Leeds.—Brochure C.M.4. Descriptive catalogue of crushing, measuring, grinding, mixing, briquetting, washing, drying, and calcining machinery for use in the production of Portland or natural cements.

Sir William Arrol and Co., Limited, Glasgow.—Illustrated pamphlet giving views of various bridges, steel work construction for buildings, dock gates, caissons, flanging presses, hydraulic riveters, pumps, and stamping presses, numerous types of cranes and transporters, steam navvies, and a rotary tunnelling machine made by the firm.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Municipal and County Engineers: West Midland District.—Council House, Birmingham. Paper, "Municipal Engineering Education," by Mr. E. G. Timbrell. 5.30 p.m.

TO-DAY AND TILL THURSDAY, NOVEMBER 29TH.

Public Works, Roads and Transport Congress and Exhibition. Agricultural Hall, Islington, N. 2.

TO-DAY AND TILL DECEMBER 1ST.

Commercial Motor and Roads Development Exhibition. Olympia. 10 a.m. each day.

SATURDAY, NOVEMBER 24TH.

Institution of Automobile Engineers.—Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Informal meeting. Demonstration and discussion on "Ignition Systems." 6.30 p.m.

Institution of Automobile Engineers.—Visit of London graduates to the printing works of the *News of the World*, Bouverie-street, E.C. 4. 7 p.m.

MONDAY, NOVEMBER 26TH.

Northampton Engineering College Engineering Society.—Northampton Engineering College, St. John-street, E.C. 1. Paper, "Management of a Sand and Flint Quarry," by Mr. F. E. A. Manning. 5.30 p.m.

TUESDAY, NOVEMBER 27TH.

Institution of Civil Engineers.—Great George-street, Westminster, S.W. 1. Further discussion on "The Effect of Groyning on Some Parts of the English Coast," by Mr. R. F. Grantham, and "The Tides from an Engineer's Standpoint," by Mr. E. W. Hollingworth. 6 p.m.

Optical Society.—Imperial College of Science, Imperial Institute-road, South Kensington, S.W. 7. "Contributions to the History of the Spectacle Trade from the Earliest Times to Thomas Young's Appearance," by Dr. M. von Ruhr. 8 p.m.

WEDNESDAY, NOVEMBER 28TH.

Institution of Automobile Engineers: North of England Centre.—Milton Hall, 244, Deansgate, Manchester. Paper, "The Misuse of the Internal Combustion Engine and Suggestions for its More Efficient Application," by Mr. L. Murphy. 6.30 p.m.

Institution of Civil Engineers.—Great George-street, Westminster, S.W. 1. Paper, "Rotary Converters for Railway Use," by Mr. R. W. Mountain. 6 p.m.

THURSDAY, NOVEMBER 29TH.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C. 2. Joint meeting with the Physical Society of London. Discussion, "Loud Speakers for Wireless and Other Purposes." 5.30 p.m.

Institution of Mining Engineers.—The Geological Society, Burlington House, Piccadilly, W. 1. Annual general meeting 11 a.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Lecturette, "Technical Arbitrations," by Mr. W. A. Tookey. 7.30 p.m.

Royal Aeronautical Society.—Royal Society of Arts, 18, John-street, Adelphi, W.C. 2. Paper, "The Development of High-speed Aircraft," by Major R. H. Mayo. 5.30 p.m.

FRIDAY, NOVEMBER 30TH.

Institution of Aeronautical Engineers.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Lecture, "The Result of Twelve Years' Welded Tube Construction and the Development of Cantilever Wings," by Mr. A. H. G. Fokker. 7.30 p.m.

Institution of Mechanical Engineers.—Storey's-gate, Westminster, S.W. 1. "Clyde Marine Oil Engines," by Professor A. L. Mellanby. 6 p.m.

Institution of Mining Engineers.—Visit to Wembley Park to inspect the coal mining industry exhibit, and to see the progress in the laying out of the grounds and buildings of the British Empire Exhibition.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Lecturette, "Notes on Design of Paraffin Motors," by Mr. S. G. Saunders. 7.30 p.m.

TUESDAY, DECEMBER 4TH.

Institution of Engineers and Shipbuilders in Scotland.—39, Elmbank-crescent, Glasgow. Discussion on paper, "Pipe Bending by Machinery," by Mr. Carl R. H. Bonn. Paper, "The Board of Trade and Merchant Shipping," by Mr. F. R. Blair. 7.30 p.m.

Institute of Marine Engineers.—85/88, The Minories, Tower-hill, E. 1. "Spontaneous Ignition of Coal," by Mr. J. H. Anderson. 6.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

At the recently held annual general meeting of the Engineers' Club, Sir T. Harris Spencer, K.B.E., and Mr. C. H. Wordingham, M. Inst. C.E., were elected Vice-presidents of the Club.

Joseph Kaye and Sons, Limited, inform us that they have lately secured the registration of a new telegraphic address for their Leeds office and works, namely, "Serrated, Leeds," in place of the original address "Wedge, Leeds."

The Buda Company England, of 75, Evershot-road, Stroud Green, London, N. 4, asks us to state that it has appointed Armytage and Sons, Limited, Sheaf-street, Sheffield, its sole agents in the counties of Yorkshire, Nottinghamshire and Derbyshire for the sale of its productions.

Joseph Evans and Sons (Wolverhampton), Limited, of Culwell Works, Wolverhampton, ask us to announce that they have changed their London office from Salisbury House, London-wall, to Craven House, Kingsway, W.C. 2. Their new telephone number is Gerrard 7044, and their telegraphic address Dryosbo, Westcent, London.

Four years ago United Water Softeners, Limited, became the sole licensee for the Sharples super-centrifuge for the clarification and separation of liquids, and created a separate department for dealing with the new business. We are now informed that the original organisation having proved inadequate, a new company with the title of Super-Centrifugal Engineers, Limited, has been formed to deal exclusively with the Sharples business. No change in the directorate or management has been made, but Messrs. P. T. Sharples, A. H. Keeble, and Z. A. Toula have been added to the board.